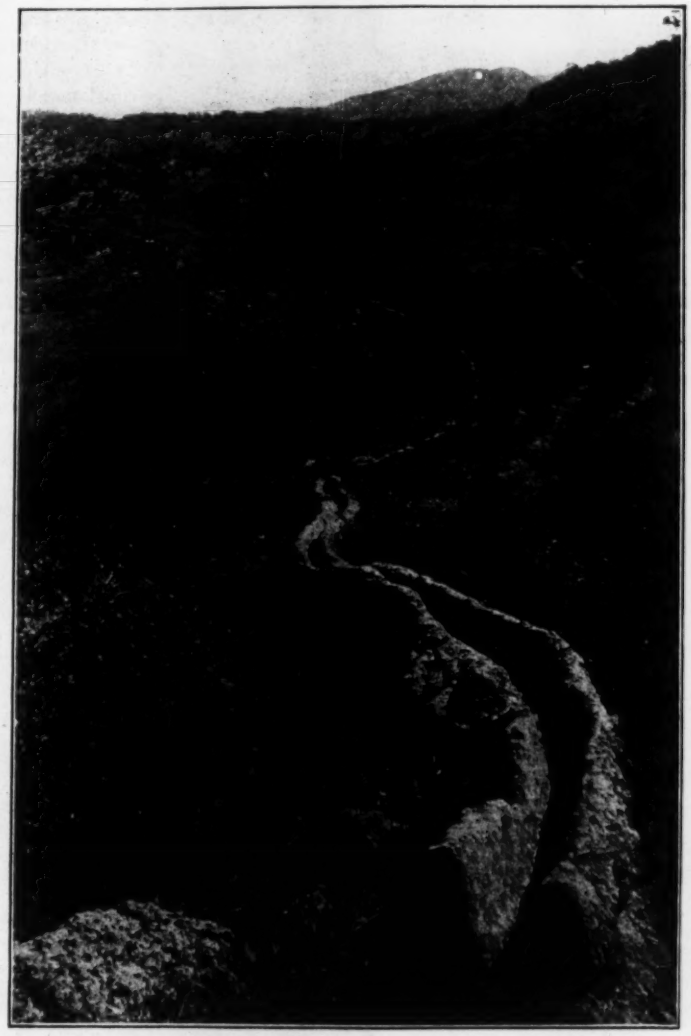
Engineering News

VOLUME 73 MARCH 25, 1915 NUMBER 12

A Prehistoric Irrigation Canal in New Mexico

By S. M. Johnson*

In a beautiful mountain valley, 74 miles west of Roswell, New Mexico, there exists a remarkable survival of the pre-Columbian period of American history. It is a natural rock-wall 4 ft. high in places, which starts at a spring and runs along a line of gradual descent a distance of three-quarters of a mile. There is a groove or trough in the top of the wall, in which the water of the spring was conducted to irrigate a mesa. There is evidence of a prehistoric town at the terminus of the wall, and it is possible that the old wall was used to convey to this town its water supply.



A Prehistoric Irrigation Ditch in Lincoln County, New Mexico

The wall is of limestone, not stratified, but sedimentary. The structural evidence is convincing that the entire wall was built up as a deposit from the flowing water. Originally it was a channel in the earth—how many centuries ago no one knows. As the water ran in the canal, the lime which was precipitated from the water formed a concrete coating on the sides. Thus day by day, week by week, month by month, century by century, while Crusaders hurled themselves against the Crescent, while Columbus sailed, while Milton wrote and Whitefield preached and Washington led the patriots, the old wall grew. How long did it take for nature to build the wall? Allowing a deposit of 1 in. in 20 years, it would be over 1000 years in forming.

From the main walls several laterals diverge, while another main wall leads from the spring in another direction.

It seems strange that this remarkable evidence of irrigation work by prehistoric peoples should remain until now unknown. Ranchmen have resided in the valley since 1875. Not long after the Mexican War, the Government established a military post, Fort Stanton, not 25 miles from the old wall. Yet the first tidings of discovery were carried by the writer to the Bureau of American Ethnology at the Smithsonian Institution on Jan. 2, 1915. This remarkable monument is near the town of Ruidoso, in Lincoln County, N. M., in plain sight of tourists who use the Southern National Highway between Roswell and El Paso.

There are several theories as to how the lime deposit was formed by the flowing spring water. It is well known that water containing carbonic acid gas in solution dissolves calcium carbonate. The spring water may have been so heavily charged with gas and dissolved limestone that part of the gas escaped as the water flowed along and precipitated the limestone. If the water issued very cold from the spring, it would be heated as it flowed along under the intense sun of New Mexico, and its gas content would be driven off. Or the water may have carried the dissolved lime as an oxide and deposited it as a carbonate as the water in flowing along the channel absorbed carbonic acid gas from the air and precipitated the lime.

*Roswell, New Mexico.

New Coast Line of Northern Pacific Ry. near Tacoma

The new double-track low-grade cutoff line of the Northern Pacific Ry. between Tacoma and Tenino, Wash., 44.3 miles, completes the reconstruction and double-tracking between Seattle, Wash., and Portland, Ore. It also gives a direct train movement through the station at Tacoma, while the old line required a reverse movement of trains. The old line is single track, with 1% grades in both directions and with 2.2 mi. of 2.2% grade ascending southward out of Tacoma. The tonnage rating southbound is 2000 tons, and three pusher engines were required to help the full-tonnage trains on the heavy grade at South Tacoma.

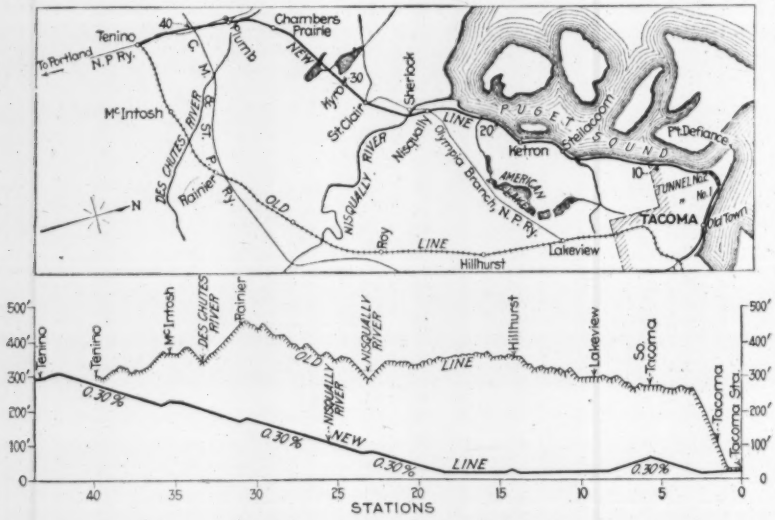


FIG. 1. PLAN AND PROFILE OF OLD AND NEW LINES BETWEEN TACOMA AND TENINO, WASH.; NORTHERN PACIFIC RY.

The plan and profile of the old and new lines between Tacoma and Tenino are shown in Fig. 1, and the marked advantage of the latter is clearly evident from a comparison of the two profiles. The principal comparative features of the old and new lines are given in the accompanying table.

	New Line	Old Line
Distance, miles	44.30	41.26
Max. grade	0.3%	2.20%
Max. curve	3°	10°
Total curvature	1347°	824°
Total rise and fall	421 ft.	1244 ft.

SEA WALL AND EMBANKMENT

Where the line runs along the shore of Puget Sound it was necessary to build a temporary sea wall for about 12 miles, owing to the tidal range of 21 ft. Pile and timber construction was used, as shown in Fig. 2, and later riprap rock was placed in front of this wall in order to give a permanent protection for the embankment, as shown in Figs. 2 and 3. This was necessary, as the teredo is very active along this portion of the Sound and untreated timber is very quickly destroyed.

The adoption of this type of sea-wall design was determined by several considerations. The topographical conditions were such that a substantial trestle would have to be constructed, and the foundation conditions were such that a gravity or reinforced-concrete wall would be insecure without excessive depth of foundation. Material for a concrete wall would have to be quarried in the mountains and shipped by rail to the Sound, then boat to the work, while material for the riprap was able by barge haul. The location of the wall and amount of riprap were determined by the character of foundations, which are subject to scour during storms.

Finally, the type adopted was very much the cheap on account of the low price for riprap, and it is considered that it really furnishes a better protection against storms than a vertical concrete wall. The riprap consisted stone of derrick size, with smaller stone to fill the voids. It was brought on barges and loaded by derricks traveling along the timber sea wall.

The wall as originally designed was for slag or heavy material weighing 195 lb. per cu.ft. The material actually purchased weighed only 135 lb. per ft. and the section of the wall had to be changed considerably. It was constructed with a slope of 1 on 1¼, and with varying thickness, being made sufficient to act as a retaining wall when the timber failed due to the action of the teredo.

THE POINT DEFIANCE TUNNEL

There are two tunnels on the line, 300 ft. and 4403 ft. long, both double track and lined with concrete. The larger tunnel is that at Point Defiance, and here some trouble was encountered. It was driven through compact sand, carrying very little water, with thin layers (or lobes) of clay in pockets, and gravel streaks. It was necessary to timber the tunnel as the excavation progressed. The timbers were 12x12 in., the sets being placed generally 2 ft. c. to c., with 4-in. lagging. The timbering was followed by the concrete lining, with invert, the latter being built in 15-ft. sections alternating with 5-ft. openings. The concrete was a 1:2:4 mixture.

Before the concrete was all in place a cave-in occurred about 1000 ft. from the east end and delayed the work considerably. An exceptionally heavy lining of reinforced concrete was placed subsequently at this point.

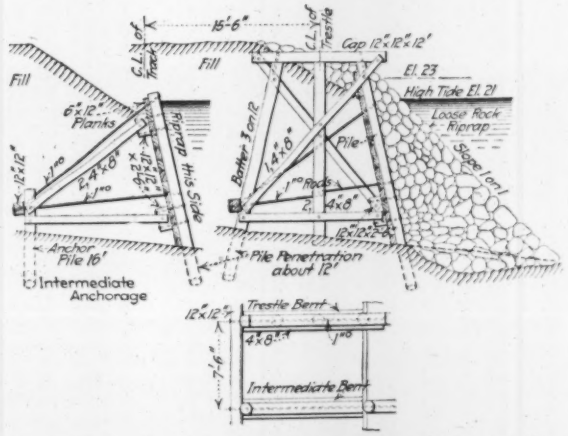


FIG. 2. TIMBER SEA-WALL WITH EARTH FILL AND RIPRAP PROTECTION FOR NORTHERN PACIFIC RY. LINE ALONG THE SHORE OF PUGET SOUND

FIG. 3. EMBANKMENT WITH TIMBER SEA-WALL AND RIPRAP PROTECTION

The section of the lining was varied at different points on account of the various classes of material encountered.

The ordinary sections of the tunnel and lining are shown at (*A*) and (*B*) in Fig. 4, the heavier section shown being used both with and without reinforcement. At the east portal (*C*) a still heavier reinforced section was employed, the sidewalls being 3½ ft. thick at the springing and 6 ft. at the base. For about 101 ft. at the slip, the reinforced section was as shown at (*D*), Fig. 4, except that at its ends the roof thickness was reduced to 30 in. instead of 42 in. The greater thickness of roof through the slide was given on the inside of the tunnel.

The method of driving through the slide is shown at the right in Fig. 4. The two drifts were carried through first and thoroughly timbered. Then the lagging was cut and short side drifts were excavated to the outer line of the enlarged lining, these side drifts being kept far enough apart to insure stability of the material between them. As soon as each widened drift was completed it was filled with concrete to the level of the wall plate, the remaining posts of the original timbering of the normal tunnel section being left embedded in the concrete. After the concrete in each side drift had set, additional sections of these drifts were excavated and concreted. In this concreting, an ample supply of dowels and short rods was used to insure the binding together of the several short sections into one monolithic mass.

The tunnel driving was started on the ordinary top-heading method, with poling boards. On account of the favorable conditions steel roof shields were installed, semi-circular in form and traveling on the wall plates. Each shield was forced ahead by twelve 80-ton jacks. The work was commenced in April, 1912, and excavation was completed June 21, 1913. The highest monthly record was 731 ft., for May, 1913. The contractor, Nelson Bennett, of Tacoma, died before the tunnel was finished and the work was completed under the direction of Mrs. Bennett.

BRIDGES

There are three steel bridges (all double track), with girder and deck truss spans, while the one at Steilacoom Creek has a 96-ft. vertical-lift span of the Strauss type. The bridges have concrete piers with pile foundation. The wooden trestles aggregate over 3500 ft. Some of the culverts are of reinforced-concrete pipe, 24 and 36-in. diameter, in 8-ft. lengths. This pipe was made by the railway company at its plant at Auburn, Wash. There are also concrete arch culverts of 6 to 20 ft. span.

TRACK

The line is double-track, laid with 90-lb. 33-ft. rails of openhearth steel, with 19 ties per rail length, and tie plates on all ties. Two rail anchors per rail are used on ascending grades and four on descending grades. The turnouts have No. 11 spring-rail frogs. The passing tracks are 3600 ft. long, laid with 85-lb. rails. All tracks are ballasted with gravel obtained from cuts along the line.

For this and the succeeding information we are indebted to W. L. Darling, Chief Engineer of the Northern Pacific Ry., and J. C. Breedlove, Assistant Engineer, in charge of the work.

SLIDES IN CUTS

The Day Island cut (at 10¼ miles from Tacoma) gave unexpected trouble as there were no surface indications to cause suspicion and in the smaller cuts adjacent to the Tacoma end very hard cemented material had been found. The cut was in ground sloping gradually back from the Sound, and was about 700 ft. long, with a maximum depth of 50 ft. on the center line. It was estimated at 99,000 cu.yd., but from Aug. 5, 1913, to Sept. 18, 1914, about 294,000 yd. was removed by steam shovel. The cut broke back to a maximum distance of 360 ft. from the track, at which point a depth of about 130 ft. was reached. It would have been necessary to remove a larger yardage had not a pile bulkhead been built for a distance of 630 ft. The penetration of the piles averaged about 17 ft. The material in the cut was loam, with some blue clay which carried a considerable amount of water.

The Tenino cut (at Mile 43) was estimated at 131,000 yd., but there was removed before its completion 866,000 yd. On the north side of the cut there was a slide for a length of 850 ft., extending back a distance of 680 ft. from the track. Early in 1914 a smaller slide appeared

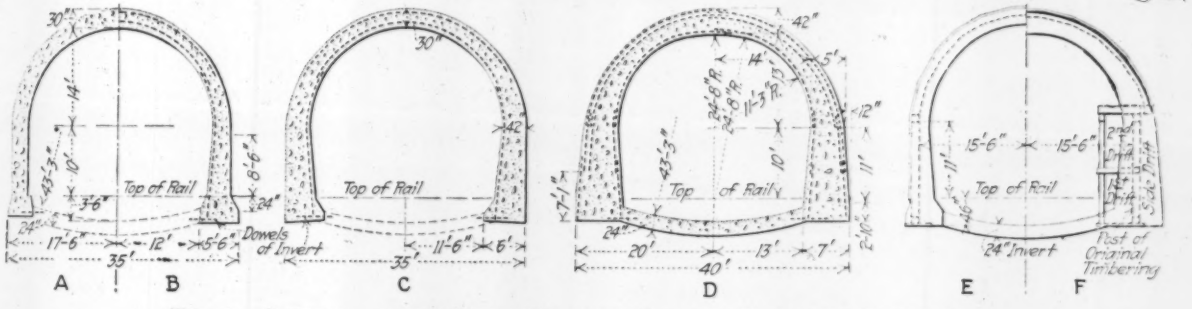


FIG. 4. SECTIONS OF THE POINT DEFIANCE TUNNEL; NORTHERN PACIFIC RY.

(A, light lining; B, heavier lining, with and without reinforcement; C, reinforced lining at east end, near slide; D, lining through slide; E, timbering of normal section; F, timbering for heavy lining through slide)

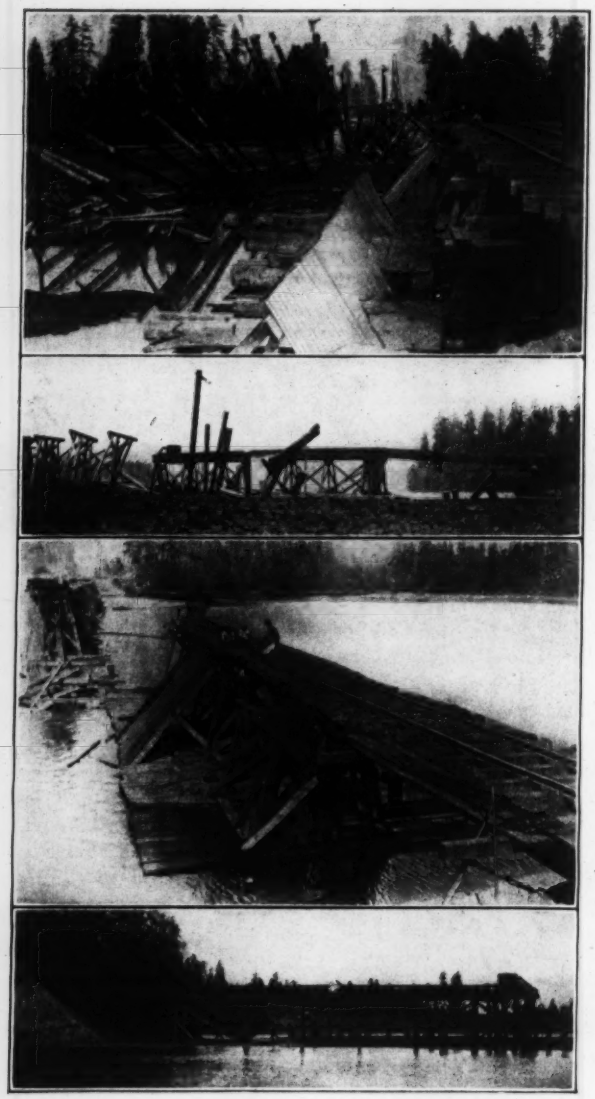


FIG. 5. BUILDING A FILL ACROSS PATTERSON LAKE

Upper View—The last of the temporary trestle, with piles lifted and overturned by the upheaval of the lake bottom, which is shown to have risen above the water.

Second View—Wreckage of temporary trestle, and lake bottom heaved above the water. In the center, beyond the wreckage, is the new dumping trestle on pontoons, with trussed stringer span to end of fill.

Third View—Dumping trestle on timber float or raft, with apron for delivering material clear of float. At the left is the end of the wrecked pile trestle.

Bottom View—Dumping trestle on pontoons, with 60-ft. trussed stringer span to end of fill. The inclined aprons at sides of trestle are not yet built.

on the south side. This measured 600 ft. along the track and extended back 270 ft. The greatest difficulty was with the first slide in this cut, where the material was a partially formed sandstone; this material broke up as the slide moved toward the track until it had lost all indications that it had ever been rock. This cut carried a very small amount of water. As nearly as could be determined the slide was moving on the harder rock beneath it. A small portion of this rock was encountered at grade.

In this cut it was impossible to drive piles to form bulkheads to hold the material back. The maximum depth on the center line was about 50 ft. This cut was commenced Mar. 29, 1912, and completed Sept. 8, 1914, but no steam-shovel work was done between Nov. 18, 1913, and Apr. 19, 1914.

CONSTRUCTING FILL WITH FLOATING DUMP

Special difficulties were encountered in building the fill across Patterson Lake, near mile-post 32. The width of the lake, measured along the center line, was 1350 ft., and it was originally intended by the contractors to make the fill across it by dumping from a trestle, using three-pile bents with piles approximately 80 ft. long. Near the center of the lake they drove four test piles, 115 ft. long. As the center of the lake was reached, it was necessary to cap the piles above the water and place frame bents on them in order to get the necessary elevation for dumping. For this construction four-pile bents and four-post bents were used.

The soft mud of the lake bottom heaved as the fill was deposited, throwing the fill out of line and lifting the piles bodily so that the trestle collapsed. For considerable areas the mud rose above the surface of the water. It was soon evident that the trestle could not be kept in condition to carry the equipment, which consisted of 12-yd. standard-gage air-dump cars. When the contractors abandoned the idea of keeping the temporary trestle in place, they tried the use of log floats or rafts to support a dumping trestle. Some stages of the work on this fill are shown in Fig. 5.

This proved successful, but later on the log floats were replaced by pontoons carrying a trestle of framed bents, as shown in Fig. 6, sloping aprons extending from the trestle to the sides of the pontoon to deliver the material in place. This floating trestle was kept ahead of the end of the fill, being connected to it by a 60-ft. span of trussed timber stringers, as shown.

One steam shovel, with the standard-gage equipment noted, started filling at the east end on Feb. 25, 1913. This was replaced on June 11 by another shovel with 4-yd. narrow-gage dump cars, the first machine being

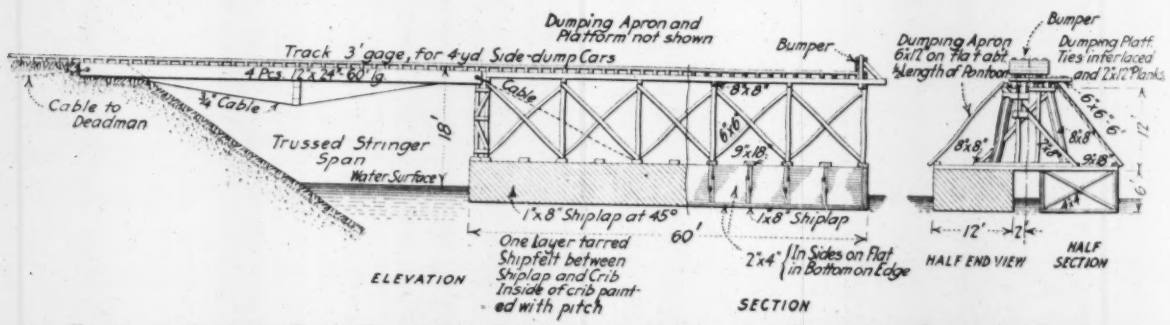


FIG. 6. A FLOATING DUMP TRESTLE ON PONTOONS FOR MAKING THE FILL ACROSS PATTERSON LAKE

moved to the west end. The material was mainly gravel and sand, and 761,000 yd. was required for a single-track fill. This was afterwards widened for double track by hauling material from the Tenino slide (already described), 72,000 yd. being required for this additional width. The double-track fill was completed June 25, 1914.

The bottom of the lake was heaved above the surface of the water in some places, but this upheaval is settling gradually and it is expected that in time it will disappear below the water.

A Garbage and Rubbish Incinerator Recommended for Albany, N. Y.

A high-temperature garbage and rubbish incinerator, with the use of steam to pump sewage and the use of clinker for concrete for pavement foundations, has been recommended in a report made to the Board of Contract and Supply of Albany, N. Y., by Hering & Gregory, of New York City. Ashes sufficient to aid in combustion and to produce a usable clinker would be taken to the incinerator from near-by points, and the remainder of the ashes would be used for filling low lands in various parts of the city.

The population of Albany increased from 90,758 in 1880 to only 100,253 in 1910. A police census in 1914 placed the population at about 109,000. The report under consideration assumes a population of 120,000 in 1920-25, and all calculations are based on that figure.

At present all classes of refuse in Albany are collected privately, except that in the section between Pearl St. and the Hudson River, comprising 17 to 20% of the population, garbage is collected by contract. In the remaining part of the city, farmers collect garbage free and feed it to hogs and chickens. Some residence streets are served by 15 different collectors and some are practically without service. All sorts of wagons are used. Householders pay "ashmen" 10c. per bbl. for removing ashes and rubbish. These wastes are disposed of on dumps cared for by the city at a cost of $6800 a year. It is estimated that householders pay an average of $1 per capita for ashes and rubbish collection, which would make $120,000 for a population of 120,000. The garbage-collection contractor is now paid $2435 a year, against $4934 for the previous year. The estimated present cost of wastes collection and disposal is therefore $129,235, or $1.07 per capita, for an unsatisfactory service.

The average daily wastes for 120,000 population are assumed as 39 tons of garbage, with 50% excess, or 58 tons, in summer; rubbish, 19 tons, with 20% excess, or 22 tons, in summer; thus making 58 tons average and 80 tons summer total. On a basis of 1 part of ashes to 3 parts of combined garbage and rubbish, an incinerator capacity of 106 tons a day is required, and the estimates are based on this figure. The yearly quantity to be burned is 32,900 tons, of which 12,000 is garbage, 6000 tons is rubbish and 14,900 tons is ashes. Assuming that 20% of the total is required to provide steam for works purposes, that 1 lb. of this mixed refuse will evaporate 1 lb. of water, that 1 lb. of coal will evaporate 7 lb. of water, that the daily sewage pumpage will average 30,000,000 gal. lifted 38 ft. with a pump duty of 50,000,000 ft.-lb., then the steam from the refuse would save 3750 tons of coal, which at $2.20 per ton would mean a saving of $8250 per year in coal required at the sewage-pumping station.

The usable clinker is estimated at 7400 tons, or 12,300 cu.yd., worth 75c. per yard for concrete, or a total of $9225.

The capital outlay for wastes disposal is estimated as $235,070, of which $35,420 is for collection equipment and $199,650 for disposal equipment. The estimated net annual charges total $142,290, of which $122,400 is for collection and $19,890 for disposal. For 66,000 tons a year this averages $2.16 a ton, of which $1.86 is for collection and 30c. is for disposal. On a population basis, the average cost is $1.19 per capita, of which $1.02 is for collection and 17c. for disposal.*

If the extra boiler equipment for the sewage pumps were placed in the incinerator building, and the incinerator furnaces were equipped with auxiliary coal grates, as has been done in some British plants, $35,070 could be saved on construction cost, and labor savings effected which would reduce the annual charges by $13,330, or 11c. per capita.

Besides the project just outlined, estimates were made for separate collections of garbage, rubbish and ashes, and for disposal of garbage by reduction, rubbish by incineration, and ashes for filling. Although this plan would require $16,650 less capital outlay than the other one, it would cost $24,830 more in annual charges. The total capital outlay for this scheme would be $218,410, of which $41,420 would be for collection and $176,990 for disposal. The total annual charge would be $167,120, of which $148,650 would be for collection and $18,470 for disposal. This plan would cost $1.39 per capita and $2.53 per ton. It may be added that it assumes 3% grease recovery, worth 3½c. per lb., and 11% of tankage, worth $7 a ton.

Finally, it may be noted that Hering & Gregory make acknowledgments of coöperation by Wallace Greenalch, Commissioner of Public Works, Frank R. Lanagan, City Engineer, and G. Henry DeRouville, City Garbage Inspector.

Reorganization of the Working Force of the U. S. Patent Office was provided for by a bill approved by Commissioner Ewing of the Patent Office, whose enactment was announced as one of the achievements of the Congress just closed in a statement sent out by the Interior Department just after adjournment. Unfortunately, the bill, although it was passed without opposition by both the House and the Senate, is not a law. It was passed by the Senate on the last night of the session and in some mysterious way, as yet unexplained, never reached the enrolling clerk to be enrolled for the President's signature, and the omission was not noticed until after the adjournment of Congress. It is stated that a new bill will be introduced and passed early in the next session of Congress.

Ventilating System of the Philadelphia Academy of Music—The Dec. 12 "Bulletin" of the Engineers' Club of Philadelphia contains the following:

During the past summer the Academy of Music has installed a heating, ventilating and air conditioning equipment. Fresh air is brought from the roof through an air shaft to the cellar, where it is tempered, washed and reheated, and then forced into the house through five hundred mushrooms placed under the seats. By this system a volume of air of more than 40,000 cu.ft. per min. is admitted over the lower floor at such a low velocity that it is not noticeable to the audience, and, passing upward through the amphitheater into a system of ducts, the air is finally led to the attic space, where it is delivered out of doors. The air temperature is automatically controlled by means of a series of thermostats so that the temperature desired is maintained, thus preventing cold or hot drafts. This is the first playhouse in Philadelphia to install an air-washing machine.

*It should be remembered that these tonnage and per capita average costs are for garbage, rubbish and ashes. The capital charges assume 4% interest and 3.356% sinking fund, the latter to redeem the bonds in 20 years, with 4% interest allowed on the sinking-fund accumulation.

Cedars Hydro-Electric Development, St. Lawrence River

SYNOPSIS—Two articles on a 160,000-hp. development at the Cedars Rapids of the St. Lawrence River. One of the largest hydro-electric works in America in capacity and dimensions. Brief description of important features of a bold plan to build up a two-mile canal bank on the river bottom, giving a broad head-race canal dammed by the power-house substructure. Installation of the largest hydraulic power units yet built. Complete provisions to prevent ice troubles. Contractors' efforts to secure maximum progress in spite of climatic handicaps.

Features in the Design of the Cedars Works

A project is now practically completed which realizes the dreams of twenty-odd years for the development of the power of the St. Lawrence River at one of the three large rapids above Montreal. This is the plant of the Cedars Rapids Manufacturing & Power Co. (closely allied with the Montreal Light, Heat & Power Co. and the Shawinigan Power Co., the former being the company distributing electricity in the city of Montreal and the latter the concern owning the large hydro-electric station at Shawinigan Falls, 90 miles from Montreal). The Cedars plant is the fifth important hydro-electric station to feed its energy into this city—Shawinigan, Lachine, Chambly and Soulanges being the others, with a total possible output of some 400,000 hp.

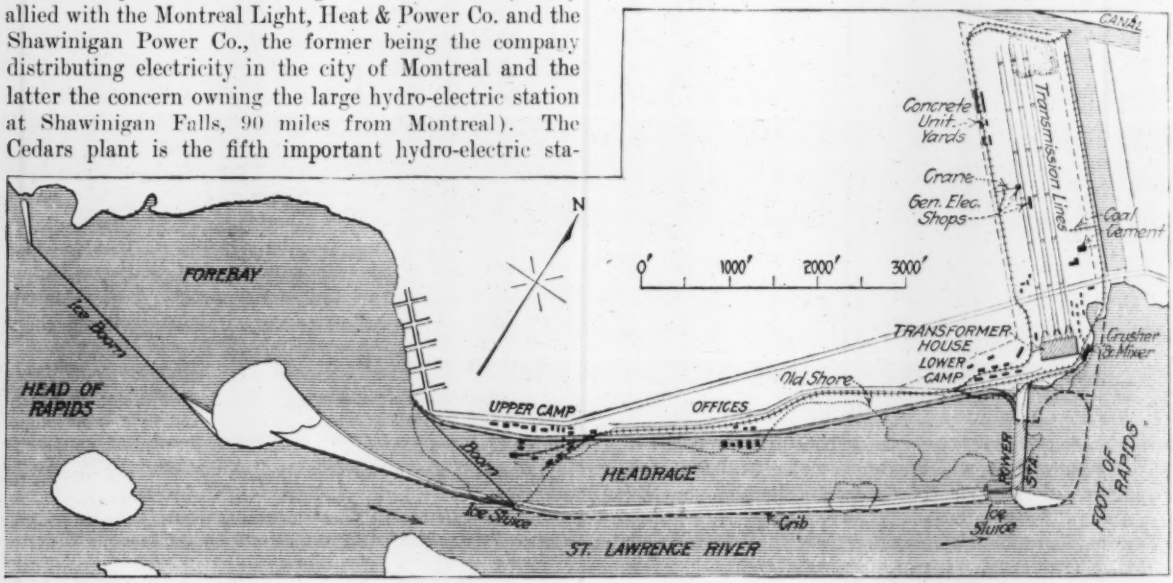


FIG. 1. GENERAL LAYOUT OF CEDARS HYDRO-ELECTRIC DEVELOPMENT

GENERAL PLANS OF DEVELOPMENT

Some 25 miles above Montreal there are three long rapids in the St. Lawrence—the Cascades, the Cedars and the Coteau. Vessels pass these rapids by the Soulanges Canal. At the Cedars the river is some 3000 ft. wide, and in the two-mile rapids there is a total fall of 32 ft. The scheme to develop power here remained dormant until some five years ago, when it was actively taken up by Henry Holgate, the well known consulting engineer of Montreal, who made the general plans which have been followed in the present construction.

After some preliminary work was done, the rights passed into the hands of the present Montreal interests and Mr. Holgate became their consulting engineer. The Cedars Rapids Manufacturing & Power Co. was organized, with Julian C. Smith, Vice-president and General Engineer of the Shawinigan Water & Power Co., in charge of construction.

The company was restricted in its operations by the natural river-bank contour—i.e., it was not able to take possession of the river bed beyond projecting points of land near the head and foot of the rapids. This in a way fixed the flow that could be utilized. Rights to 56,000 sec.-ft. were secured, and that amount can be taken at all seasons without interfering with navigation. Of the 32-ft. fall along the rapids, 30 ft. is made available for the turbines. The river flow varies somewhat during the year, of course, but the stage is remarkably stable—not varying more than 4 ft. The rapids give favorable conditions for economical power generation, since the head- and tail-race levels rise and fall together.

As shown in Fig. 1, the work is of great magnitude and covers a stretch of ground along the river some two miles from canal forebay to tailrace outlet. The layout is notably simple; there is plenty of shore room for operations, and the construction is straightforward, without great complication, so that the problems of design and construction were problems of magnitude rather than of peculiar difficulty—except that speed was necessary in the open season to make up for winter handicaps.

The present construction will provide an output of 100,000 hp., but 160,000 hp. will ultimately be developed. At first there will be nine 10,000-hp. main units, and this will be increased to 18. Water will be taken from the river just above the rapids and led through a canal along the river bank about 7000 ft. long and 700 to 1200 ft. wide. At the lower end is the power house, the substruc-

ture of which forms a dam across the foot of the canal. The tailrace discharges into the river below the rapids.

When the work was first considered, it was ascertained that no construction company would bid on the job previous to its being unwatered, and no contractors would tender either a unit price or a lump sum on the unwatering. It was therefore deemed advisable for the Cedars company to proceed with the unwatering and the early stages of the construction work, organizing its own force and utilizing the construction department of the Shawinigan company (under the direction of which the large development at Shawinigan Falls had been made). This early work involved the building of the coffer-dams and putting down the construction plant. Work was carried on in this manner for about a year; at that time the site of the work was practically unwatered and all of the coffer-dams had been completed. Tenders were then received from various contractors for the excavation and construction. The contracts for the main part of the development were awarded to Fraser, Brace & Co., of New York.

The cost of the final development will be in the vicinity of $75 per horsepower capacity, including cost of real estate, water rights, etc. Owing to the steady flow, it is anticipated that full power will be available the entire year round. On account of the unified operation with other hydro-electric plants where water can be impounded (notably Shawinigan and Chambly) it is expected that the load factor of the Cedars plant can be kept up to 90% after the first year's operation.

Canal

The canal extends along the river bank for about two miles between an outer embankment built up in the river channel and an inner bank placed back from the original shore line. Near the upper end of the canal site, at Cedars Village, is a natural bay which becomes the forebay and through which water is drawn at right angles to the river current. The inner bank of the canal has been placed as for the ultimate construction, although the canal excavation has not been made of full width. When the final development is carried out, the canal can easily be dredged to full width and depth.

The canal banks were to be earth fills with stone riprap, as the preliminary investigations of the site of excavation had indicated plenty of clay and little rock. However, work disclosed an abundance of rock and it was decided to build the south bank as a rock fill with a large earth section inside.

A dry site for excavation was secured by perfecting natural barriers at the upper and lower ends of the proposed canal and by sinking crib dams along the line of the outer bank and around the lower end of the tailrace site. The average distance of the cribs from shore was 800 ft. and the maximum 1200 ft. The excavation overran the fill considerably so that the outer bank was used also as a spoil dump, increasing the dimensions beyond those actually necessary.

The excavation for the present partial development will total about 1,800,000 cu.yd. of earth and 650,000 cu.yd. of rock. The canal is not now excavated to the full width necessary for the eventual maximum flow. For the ultimate development 1,000,000 cu.yd. of earth and 300,000 cu.yd. of rock additional will have to be removed.

As the land drainage between the river and the nearby Soulanges Canal is toward the river, a deep ditch, partly paved, has been carried along the land side of the north canal bank and led to the tailrace.

Fig. 2. View along Cedars Canal toward Power House

Where the head against the outer canal bank is large, there is a concrete core-wall, as shown in Fig. 2. Where the head between canal and river is small, as in the upper reaches of the canal, it was deemed quite sufficient to excavate a trench in the rock and to let the clay blanket fill this.

Where the ice sluices are built into the south bank, wing walls are used to prevent wash, and core-wall projections cut off possible seepage along the sides of the sluiceway. An instance is seen in Fig. 5. For the greater length of bank, the overburden to rock has been taken off before placing the rock fill and earth blanket, but for a few hundred feet either side of the first ice sluices

the head is negligible and preliminary stripping was not done.

Generating Station

The length of the power station for the initial development is 667 ft.; the building extends from the outer bank toward the shore and connects with the present shore line by a rock-filled crib dam. This crib is 48 ft. high and so placed that the work of extending the power house for the remaining 513 ft. to the new shore line for the final development may be carried on without disturbing the crib. When the power house is ready for the final development the crib and fill may be removed by dredging.

A typical cross-section through the power station on the center line of one of the main units is shown in Fig. 9. Typical plan and sections through the substructure are shown in Fig. 8. The substructure is of reinforced concrete with the turbine casings and draft tubes formed in the foundations. In the initial construction, space is provided for ten 10,000-hp. wheels, although only nine have been installed. Three 1500-hp. units will furnish the excitation and auxiliary current supplies. For the final development it is likely that there will be three more of these smaller units; then, two will be used for supplying auxiliary apparatus and two will be spare machines.

The weight of the generator frame and of the rotating parts of the generator and turbine, which are suspended from the top of the generator, is transferred to the foundations by the speed ring. To support the floor during construction six concrete columns, 2 ft. square, were placed between the top and bottom of the spiral casings, but these were blasted away after the rings were secured in position. (The turbines are the largest, in dimensions, yet built; turbines and generators are to be further described in a later article.)

On the upstream side of the power-house substructure, a hanging wall projects below water level, serving as a skimmer to hold back ice and floating rubbish. Just below this are the stop-log grooves and back of these the inclined racks. The grooves for the racks are built with one side vertical for ease in lifting out.

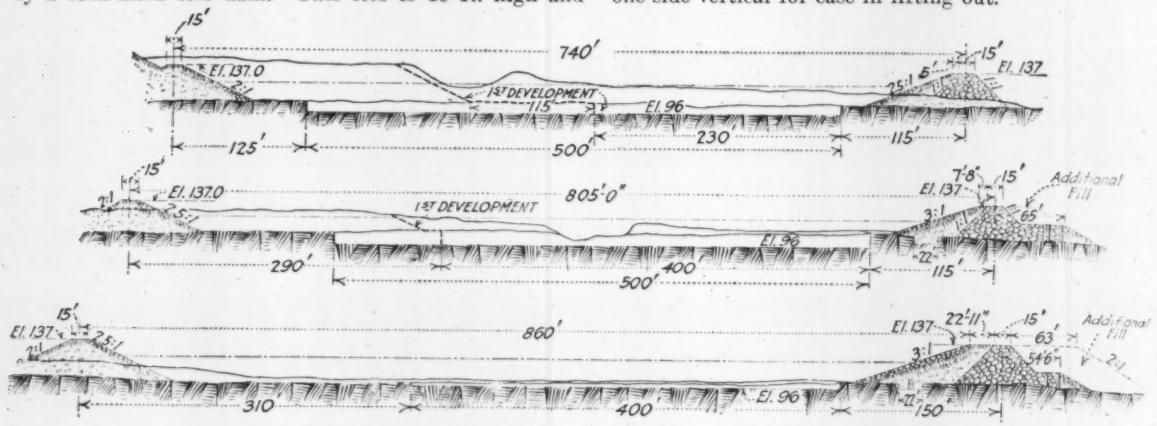


Fig. 3. Typical Cross-Sections of Cedars Canal and Banks

The main gates are in two parts. The lower half extends from the floor of the casing entrance about half way up. From the top of the first half a second set of grooves rises from a transverse beam on which the upper leaf rests. The lower leaf may be raised and lowered by a cable running to a motor hoist. The upper leaf has a threaded gate stem engaging with a motor-driven wormwheel. The racks can be lifted by a traveling crane, which runs the length of the gate room and the gates may be worked by this if necessary.

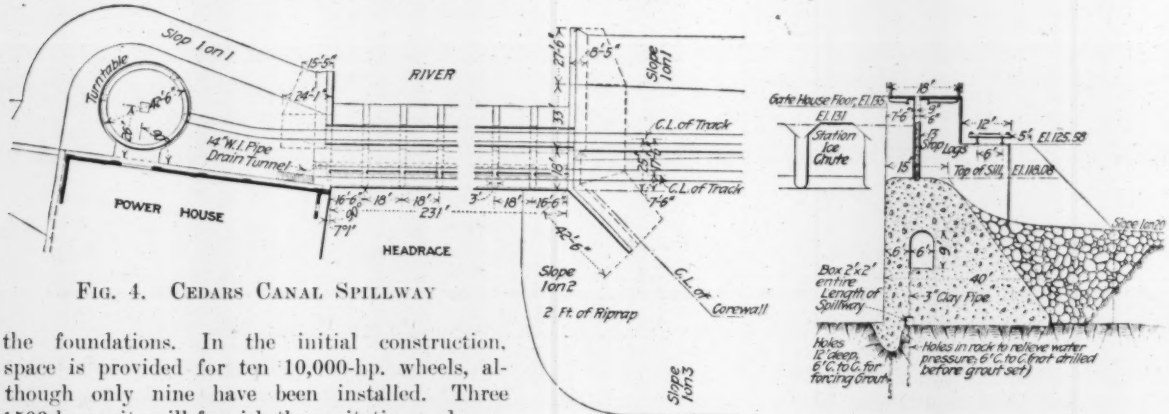


Fig. 4. Cedars Canal Spillway

Just back of the gates are air vents leading from the gate room to the roof of the turbine-casing entrance. These prevent undue pressure on the head-gates through formation of a vacuum in the casing. After closing the gates, as the casing empties the vents admit air; when water is let into the empty wheel chamber, the vents serve as air outlets.

Back of the gates is a longitudinal chamber running the length of the gate room under the floor for carrying service pipe lines. This chamber serves also as a canal and reservoir for the water discharged by the speed-control cylinders under action of the governors. The pumps

supplying the governor pressure tanks draw their supply from here after it is filtered.

Molded in the substructure on the downstream side of the station, there is a longitudinal chamber 6 ft. high and 20½ ft. wide for the ducts which house the cables from the generators. Above this is a series of chambers opening to the main generator room and the control bays; in them are located the auxiliaries, such as motor-driven

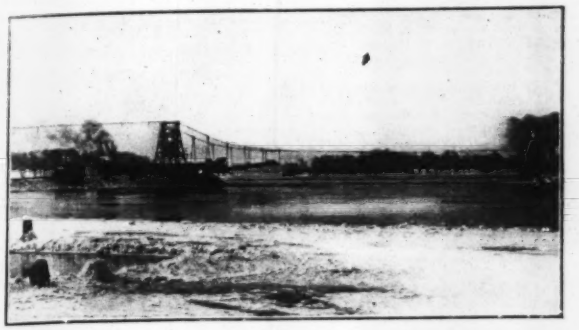


FIG. 5. BUILDING ISLE AUX VACHES DYKE

exciters, motor-driven governor pumps, and the ventilating fans for cooling the generators.

The superstructure of the building is a steel frame with reinforced-concrete wall panels, balcony floors and roof slabs. It is 125 ft. wide outside, 64 ft. high, and, for the first development stage, 667 ft. long. The concrete roof slabs and curtain walls were not cast in place but are built up of units made at a conveniently located concrete plant, and then transported and set in place. A steel frame was used instead of reinforced concrete because of the necessity of supporting a traveling crane while the frame was going up and before concrete columns could safely be loaded. (Details of the power-house construction will be given in a later article.)

On account of the gap between the first length of the power station and the shore, a trestle has been built from the power house to the transformer house, back of the crib dam, to carry the 6600-volt cables, and the cooling-water for the transformers (which will be furnished by motor-driven pumps in the power station). This trestle is only a temporary structure, designed for a load of 2500 lb. per lineal foot. The conduits after reaching shore are installed in permanent shape.

There are 110,000-volt transmission lines to Massena, N. Y., where 60,000 hp. will be taken by the Aluminum Co. of America. The rest of the power will be transmitted to Montreal, at 66,000 volts.

PROVISION FOR PROTECTION AGAINST ICE

In the climate of Montreal it is necessary, of course, to make very complete provision against interference with operation by ice, either in severe winter weather or in the early spring, when the ice is breaking up. From Fig. 1 it is seen that a large stretch of quiet water is maintained above the power house. The flow velocity in the canal is about 4 ft. per sec., maximum, and in the canal forebay about 2 ft. per sec. Under such conditions the canal and intake should freeze completely over in early winter, and this ice surface will protect the plant from needle ice coming down the main stream.

The water passages to the turbines and through the draft tubes, speed rings and turbine runners are large, so that there is not much danger anticipated from the collection of needle ice. The rack and gates are all housed and the transfer of heat would be from the submerged metal parts into the water and not the reverse, as would be the case if the racks or gates were exposed to the open air. With the flow of heat from the metal to the water there should be a temperature gradient, though inappreciable, sufficient to prevent the sticking of ice particles to the metal.

As protection from floating ice when the river breaks

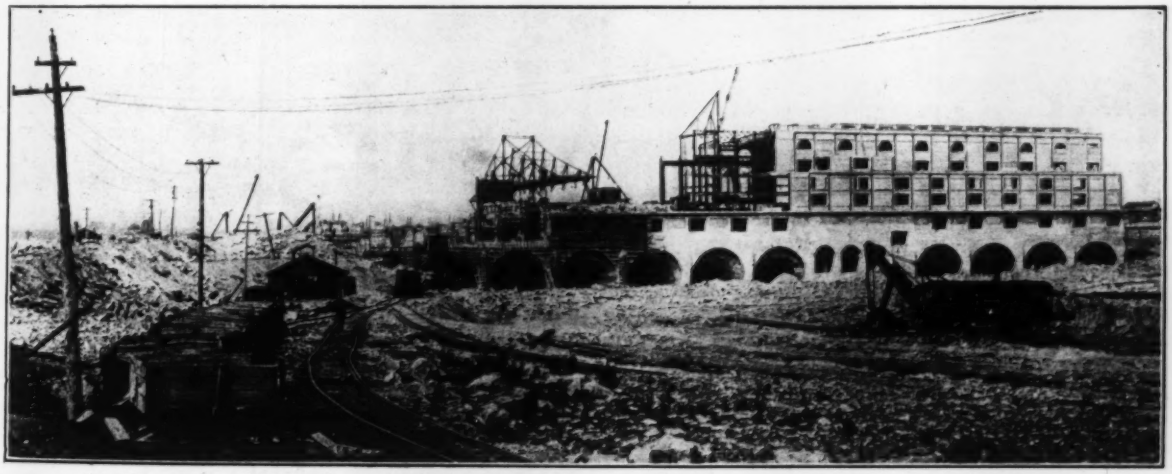


FIG. 6. GENERATING STATION AT CEDARS RAPIDS, QUEBEC, AS SEEN FROM TAILRACE
(Showing various stages of construction and Keokuk traveler at work)

The power house is exclusively a generating station; the step-up transformers and high-tension equipment are in a transformer building on shore. The maximum voltage in the generating station is that of the main units—6600 volts.

up, a long boom has been thrown across the entrance to the canal forebay from the north shore to Isle aux Vaches. Near the upper end of the south bank of the canal an ice sluice has been provided and a boom will be carried from this across to the shore at the upper end of

the north bank. The ice in the canal forebay will be led along this boom to the sluice and there discharged into the river. Similarly, when the ice breaks up in the canal below the upper sluice it may be discharged into the river through the sluice at the power-station end of the canal bank. In addition to this, there are three discharge sluices through the power house from the canal to the tailrace. These latter sluices are formed by concrete piers with overflow weirs between; for most of the year, the sluice openings will be filled by stoplogs.

Each individual unit in the power house is protected from surface ice by a curtain wall, which extends 3 ft. below the low-water level. Transverse passages through all of the turbine intake partitions are arranged in order to remove floating ice and rubbish in front of the rack

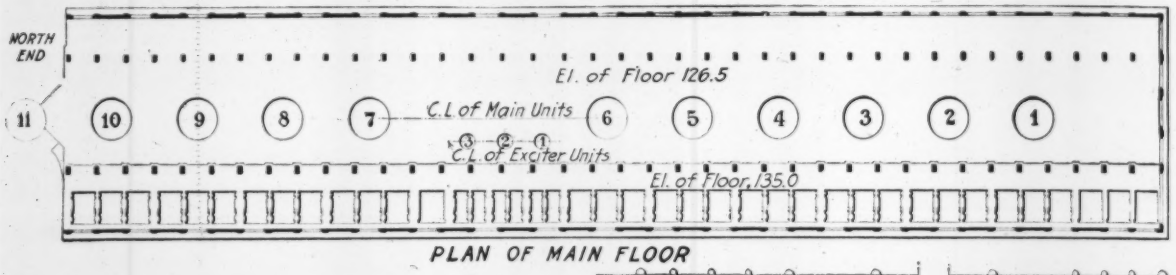


FIG. 7. PLAN AND SECTIONS OF CEDARS POWER-HOUSE SUBSTRUCTURE

out to the ice chutes. Two of the ice-chute openings are located at the south end and one is in connection with the exciter units. For the final development another ice chute will be arranged in connection with the second exciter group and a fifth at the north end of the power house.

Construction Methods at the Cedars Development

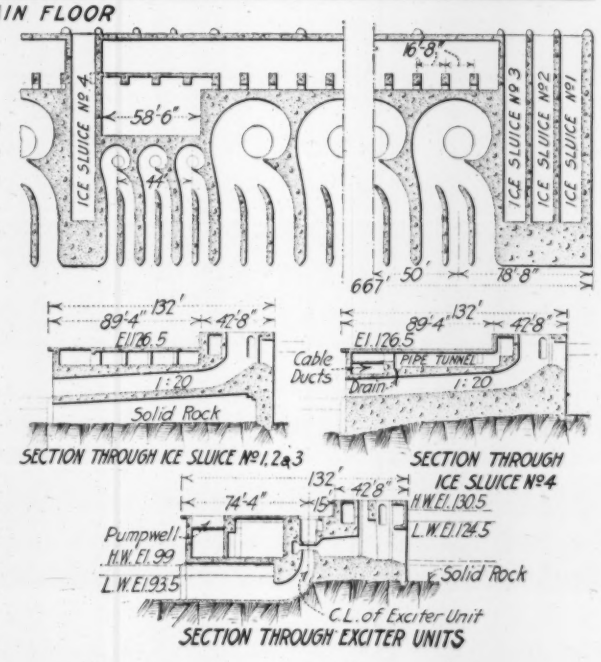
It has been noted in the preceding article how the Cedars power company found it advantageous to undertake the early construction work on the hydro-electric project at Cedars Rapids. After the coffer-dams had been put down, the site partly unwatered and preliminary construction started, in April, 1913, a general unit-price contract was let to Fraser, Brace & Co., of New York. The time set by the promoters for the completion of the entire works was short, as the saving of a year, which seemed possible, meant saving half a million dollars in bond interest and gaining a year's income—since the market was assured. The severe winter weather of the Montreal climate so hampers construction activities that operations failing completion in late fall, even by ever so little, must be deferred until spring and will usually be completed only by the following mid-summer. This condition was constantly in the mind of both engineers and contractors in jointly planning their work.

CONTRACTORS' ORGANIZATION AND EQUIPMENT

The plant was finished within the estimated cost, in less than contract time, and with harmony between company and contractors. This success the power company's officials have generously attributed to the contractors' organization, equipment and personnel. On the other hand the contractors concede that they have depended upon the reasonableness and coöperation of the company's engineers.

In April, 1913, the contractors took over the work started, the buildings, camp furnishings, supplies, materials and plant, adding thereto much of their own equipment. The most important items in the working outfit when completed included:

4 70-ton steam shovels.
1 75-ton steam shovel.
2 60-ton steam shovels.
1 50-ft.-radius dragline excavator.
1 50-ton locomotive.
1 35-ton saddle-tank locomotive.
21 25-ton saddle-tank locomotives
3 18-ton saddle-tank locomotives.
36 12-yd. dump cars.
160 6-yd. dump cars.
20 flat cars.
18 miles standard-gage track.
1 1800-ft.-span cableway dump.
1 automatic coal railroad.
1 unloader leg for receiving cement.
6 belt conveyors for sand and stone.
3 belt conveyors for cement.



2 locomotive cranes.
1 150-ft. cantilever crane.
5 traveling derricks.
5 stationary derricks.
1 80-ton-per-hr. gyratory crusher.
5 40-ton-per-hr. gyratory crushers.
1 pulverizer.
5 40-ft. concrete mixers.
1 20-ft. concrete mixer.
4 1200-ft. belt-driven air compressors.
40 3½-in. rock drills.
10 air-hammer drills.

The shop equipment included a power hammer, pipe-threading machines, drill sharpener, lathe, shaper, planer, power grindstone, band, rip and table-saws, and a wood planer.

The company owns an irregular strip of river-bank land extending from the canal forebay to the tailrace, with a broad extension to the Soulanges Canal, so that there was plenty of room for camps, workshops, storage yards, etc. Supplies were largely received over the Soulanges

Canal, for which service docks were built along the canal and on the headrace of the Soulanges power plant. As the canal is closed from December to May, large storage had to be provided for cement, sand, lumber and coal, which came by water and was mechanically transferred. There was no direct rail connection to the site and it was necessary to run cars of machinery, etc., upon floats and ferry them to the site. This made easy the task of getting in the plant, for the tracks were standard-gage and cars could be run to the exact point needed before unloading. The large items of the general contract were 1,800,000 yd. earth excavation, 650,000 yd. rock excavation, 83,000 yd. concrete in power house, 20,000 yd. concrete in spillways, etc. For all this work a complicated track system became necessary, including two underpasses at the trestles for the outer canal bank.

In the larger area at the east end of the work were the concrete-unit plant, electrical-assembly shed and storehouse, besides the cement, coal and sand storage. The camp buildings were largely grouped near the powerhouse site, including main carpenter shops, elevated water tank, blacksmith and machine-shops and store-houses. There was another large camp near the forebay with a storehouse and blacksmith shop. The hospital, doctor's office and main office were midway. As most of the concrete work was at the tailrace end, the main stone crusher and concrete-mixer plant was there. There was, however, a smaller crusher and mixer plant at the upper end.

Two standard-gage tracks came down from the canal to the station site, where they joined, one running along the shore to the upper end. There were other tracks put down from time to time as needed to move the excavated spoil, to build up the canal banks, to get concrete from mixers to station site, etc.

A large general order for lumber gave a stock valued at $150,000 just prior to beginning construction of trestles, cement sheds, crushing plants, wharves, etc. At the close of navigation in 1913 the cement storage contained 40,000 bbl., and the coal stock amounted to 10,000 long tons. Various supplies had been bought in large quantities and about $75,000 worth stored. The succeeding winter, 1913-1914, was favorable for heavy construction work, and these stocks were brought down almost to zero by the time navigation opened, about May 1.

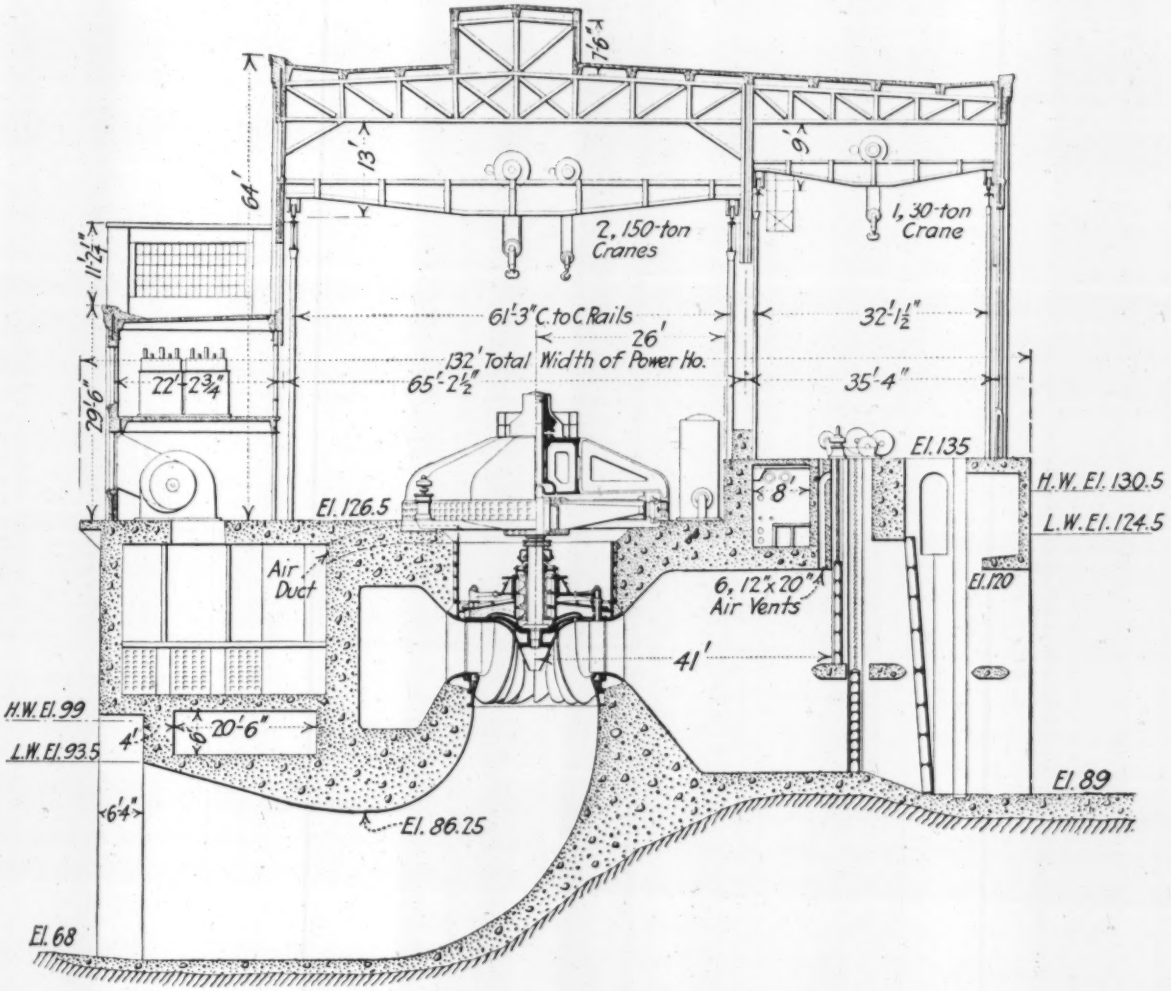


FIG. 8. SECTION THROUGH CEDARS HYDRO-ELECTRIC GENERATING STATION

CANAL AND TAILRACE EXCAVATION

The flooded sections were pumped out with motor-driven centrifugal units after the various cribs had been made tight with earth blankets. Once the site was un-

watered, comparatively little pumping served to keep the excavation dry. For the tailrace area, two 10-in. pumps normally handled the leakage, though there were two 10-in. spare units for emergency. Up to four sumps were used as the excavation progressed along the canal. Power for this work was secured from the Soulanges hydro-electric station (of the allied Provincial Light, Heat & Power Co.) near by. In fact, electric power was generally used except for locomotives, locomotive cranes, shovels, etc.

The earth excavation consisted largely of the removal of the two large points of land which formed the principal features of the old shore line. A narrow strip of the upper point was left as a dam to hold the canal bed dry; this was later dredged out.

The shore cuts in these points were some 30 ft. deep. In the upper tongue the very large proportion of large boulders made the excavation difficult. A great many boulders were too large to load into the dump cars and were left against the bank. They were then pierced by hammer drills and blasted behind the steam shovel to be removed with the next cut.

The designed elevation of the canal bottom required a very considerable excavation to lower the old river bed between the two main projecting points of land. This was almost entirely gravel, boulders and ledge. The heavier earth excavation at the intake end was underlaid with rock, which was excavated for a depth of some 10 ft., running out to nothing under the gravel and boulders. In January and February, 1914, when but little earth excavation could be made, more than 100,000 cu.yd. of rock was removed from this area by four shovels.

The tailrace excavation was a difficult problem because of the steep sloping bottom and curved shape, which caused trouble with tracks for the loaded trains. The cars were loaded at elevations as low as 69 and dumped at track elevations of 137 to 150.

The fill for the south bank was started between the upper point of land and Isle aux Vaches, after throwing a cableway and suspended track across so that the dump cars could be run over the proposed fill (Fig. 3). Only the rock fill was so placed, the inner earth blanket being dumped from tracks on the rock fill. All this material came from the excavation at the upper end of the site. The rock fill along the cribs was started from the upper and lower end of the site, taking material from the nearest excavation.

The crib fills were continued by dumping rock inward from the coffer-dams. These were gradually raised by throwing rock under the track, and trestles had to be used only for the upper half of the bank. When the rock dam was completed to the top, the remaining earth fill was dumped over the top of the rock bank and pushed into place by a high-pressure water jet. Earth was successfully worked in this way 150 ft. out from the dump track, but great care was needed to prevent wetting the material so much that it would slide into the canal.

The stone protection was dumped from the same track and was largely thrown into place by hand. But large pieces were moved by horses and chains, and in the wide parts of the bank the rock for toe protection was pulled down on stone boats.

Power-House Excavation

Excavation for the generating station included the removal of 40 ft. of earth and 33 ft. of rock. The earth was attacked in the winter of 1912-13 and the rock in May. Concreting for the power house started in a small way in July, 1913, shut down in January and February, 1914, and ended in July, 1914. The bulk of the rock was taken out by steam shovel, but the last 3 ft. and the cleaning up were done by traveling derricks.

Work on substructure, superstructure, wheel installation and electrical equipment went on simultaneously, each subcontractor on the special work starting at the north end and working outward. By the fall of 1913 four units of the substructure were ready for superstructure and machinery.

Form and Concrete Work

The forms for substructure concrete were entirely of wood. They were built up complete at the carpenter shop, sawn apart and taken to the site in pieces as large as could be conveniently handled by the locomotive crane. All were made so that they could be taken down and used again. This scheme had its counterpart in the superstructure construction and machinery installation. The aim was to reduce the number of men required on the station site and to bring in completed parts. This assisted in the rapid progress of the work.

The form erecting and concreting was spread over about five pit units and, from rock to screen-room floor, rose about 71 ft. high, so that the whole scene presented a mass of complicated form work not often seen. Upwards of 300 carpenters were engaged.

Progress was the first consideration. It was seen that from 400 to 600 cu.yd. per day would have to be placed, allowing for a slow start and inevitable slackening speed in the final month. A maximum of 650 yd. was placed in 10 hr.

It is interesting to note that for placing the substructure the traveling crane which was built for use in the construction of the Mississippi River plant at Keokuk was purchased and transferred here. However, it was not used in the same manner as on the Mississippi River work, where it moved material forward along the line of the dam as this was projected out from shore. At Cedars the traveler had its main axis at right angles to the main line of the power house and was used to transfer from feeder tracks to the various points across the width of the substructure. Also it was given added underframe to raise it 15 ft. The hoist and traveler engines, formerly run by compressed air, were supplied with steam from a portable boiler mounted in the subframe.

At Keokuk this crane traveled parallel with its main axis and along the dam; at Cedars it was moved at right angles to its axis, but parallel to the power house. The forward trucks were carried by a trestle on the rock surface close to the power-house excavation. The track for the rear trucks, which supported much less weight, was laid on a dry-rock wall rising abuot 3 ft. above the headrace excavation.

The concrete was brought to the power house from the two 40-ft. mixers on flat cars carrying 2-yd. bottom-dump buckets. Two 18-ton locomotives were detailed for this haul. The Keokuk pelican crane was manned by three operators; it never was a limiting feature. Generally it was shifted forward two or more times a day. The cantilever arm was so high that it passed over the stiff-leg derricks on excavation. It also swung into position the larger and heavier pieces of forms and was usually worked at this all day Sunday. A traveling derrick with 80-ft.

boom was mounted on the completed substructure and used to erect the forms for head works. The light forms were generally moved and erected by hand.

After sufficient excavation, enough concrete was placed to seat the draft-tube forms; then these were concreted three at a time. The forms were designed so that they could be taken down in sections and used again, assembly being about a central (vertical) rib frame. In placing the necessary layers of concrete it was attempted to keep joints normal to finished surfaces. An expansion joint was left in the piers between each two units. The mass concrete was a 1:3:6 mix; a slightly richer concrete was used for reinforced parts.

It was difficult to crush sufficient stone. During the first summer rock excavated by the shovels had to be used and there was so much unsuitable rock that the crusher platforms were congested by the large quantities of waste material. The potsdam sandstone underlying the powerhouse was almost pure silica and it cut the crushing surfaces excessively, so that the repair item on crushers was large. During the winter of 1913-14 the canal rock work was opened up so far that it was possible to set up derricks and load out by hand enough rock for crushing. This eliminated the difficulties.

The pulverizing machines had been installed with the idea of making sand for the concrete. But for most of the work it was cheaper to buy sand which was delivered in boats on the Soulanges Canal. It was during the winter that it was practical to prepare sand by machine; yet the service was severe and the repair item was large. Experiments were made with various hammers, and soft tough machine steel was found the most satisfactory.

Power and Transformer House Superstructures

The original scheme contemplated use of steel frames and brick curtain walls, but this was modified when it was found that there was plenty of rock on the work and that brick could be brought in only at greater expense and with loss of time. It was seen that the design of the two large superstructures necessarily involved the use of repetitive elements and this suggested the use of reinforced-concrete wall and roof units, which could be made under factory conditions at a favorable part of the grounds and speedily slipped into place on the steel skeleton.

It was not so necessary in the transformer house to use the frame during the installation of machinery as in the generating station. Therefore reinforced concrete was used throughout. Unit construction was employed mostly, though the ground-floor and some tall columns were made monolithic. Contracts for this work were let to the Unit Construction Co. of St. Louis. (This feature of the work was so distinctive a part of the whole construction that it will be separately described later.)

In addition to having the superstructure units made at a convenient distance from the power house, the assembly of electrical machinery has been conducted in a large shed on shore, where 50 men were employed. Here the large generators were wound from materials forwarded by the factory. The iron punchings for the stator cores of three generators were stacked here. The roof of the assembly shed was built in units so that it could be taken off to let large parts through. A traveling crane (belonging in the gate room of the power station) was installed in these storage yards and passed above the electrical contractor's shed, so that the pieces of power equipment under erection were conveniently handled between cars and shop. Better conditions for good work were secured than in the power house where concrete was being placed and the turbines were being set up.

Organization, Etc.

All the work before outlined for the Cedars development has been under the direction of Julian C. Smith and R. M. Wilson, as Hydraulic and Electrical Engineers respectively. W. D. Bergman, G. P. Hawley and Alex. Wilson as Assistant Hydraulic Engineer, Resident Engineer and Assistant Electrical Engineer, respectively, have been responsible for much of the design and construction. The early construction work of the Cedars company was under the immediate charge of C. S. Saunders, Construction Superintendent of the Shawinigan company. Of the contractors, C. E. Fraser, President, and J. H. Brace, Secretary-Treasurer, lived at the site, and their chief engineer, G. C. Clarke, spent about half his time there. The contractors' organization included J. J. McCarthy, Superintendent, and N. J. Kayser and C. H. Covey, Assistant Superintendents, besides a master mechanic, master electrician and master carpenter.

Dominion Town Planning

By Thomas Adams*

The important bearing of town planning and housing upon the conservation of life has led the Canadian Commission of Conservation to extend the work in these twin fields carried on for several years past under its Medical Adviser. Accordingly, a few months ago the Commission created a Town Planning and Housing Branch to deal with the economic, the engineering and the architectural phases of these two subjects.

The engineering aspect of town planning has to be more fully recognized than hitherto. It is idle to argue how important the engineer is in connection with town planning and how essential it is that he should take part in the early stages of any scheme. Before town planning can be made effective it should be preceded by the preparation of topographical survey maps.

The rapid urban growth within the Dominion makes it desirable that consideration should not only be given to the questions of curing evils and altering conditions already established in municipalities but that the best methods of avoiding the repetition of these evils, and the creation of worse ones, should also be thought out, so that preventive measures may be devised.

The legislation of Great Britain on town planning has so far commended itself to the Commission as the best basis for legislation in Canada so that in drafting a town-planning act it has followed the British precedent.

*Town Planning Adviser to the Conservation Commission, Ottawa, Ont. For nearly five years prior to his appointment to his present position, Mr. Adams served as town-planning expert to the Local Government Board of England. He is President of the Town Planning Institute of Great Britain. —EDITOR.

The following roughly indicates the scope and objects of town planning schemes on the lines followed in Britain:

	Objects	General Scope
Engineer and Architect	Proper Sanitary Provisions	Planning of sewerage and water-supply systems Hygienic conditions in factory and home
Engineer and Surveyor	Convenience	Highways (arterial and secondary roads and streets) Transportation (railways, waterways and highways) Location and planning of factory and warehouse areas, etc.
Architect and Surveyor	Amenity	Open space round dwellings and factories (light and air) Height and character of buildings Preservation of natural features Parks and playgrounds Civic centers and public buildings
Administrator	Coöperation	Adjacent local authorities acting in harmony Give-and-take arrangements between municipalities and owners of land
Surveyor and Administrator	Finance	Spreading of cost of scheme over period of time Adjustment of cost of developing land to character of buildings

A new housing act should also be framed as soon as possible as a model for the provincial legislatures, but much investigation into housing conditions will first be necessary. Visits will be paid to all the provinces and many of the cities in the Dominion. Conferences with representatives of provincial governments and municipalities will be held to discuss the many points which will have to be considered, especially in regard to their local or provincial application. Incidentally, the Town-Planning Branch of the Commission will give advice to municipalities with regard to local town planning schemes

Three Canadian provinces have passed town planning acts, namely, Nova Scotia, New Brunswick and Alberta. It will be one of the duties of the Commission to advise as to the proper steps to be taken to put the existing acts to the fullest and best use, to suggest desirable amendments to existing acts and to induce the other provinces to adopt town-planning acts based on the model act of the Commission, but modified to suit the conditions peculiar to each province. The aim will also be to secure, so far as possible, uniform legislation throughout the Dominion.

Collections of literature, maps, photographs and slides will probably be made by the Town Planning Branch of the Dominion Commission and placed at the disposal of those able to make use of them.

Congress St. Bridge across the Hudson River at Troy, N. Y.; Structural Features

By Henry W. Hodge*

The present highway bridge across the Hudson River at the foot of Congress St. in Troy, N. Y., is being replaced with a new structure giving greater channel openings for the increased traffic which will pass through the new waterway being constructed to Lake Champlain.

The entire structure, over 1400 ft. long, consists of five plate-girder spans, two riveted through-truss spans, and a riveted through-truss swing-span (see truss diagram, Fig. 2). While the spans are not of unusual length, they have some novel features.

Variable Panel-Length—It will be noted that the panel-lengths of the swing-span vary from 22 ft. to 38 ft., increasing with the depth of truss. This arrangement reduces the number of web members and thus decreases the weight and cost in the shop and field, and at the same time improves the appearance by keeping all diagonals about parallel.

Short Floorbeam Spacing—The arrangement of the steel floor-system is out of the usual (though it has been used by these designers on other structures) in having floorbeams spaced at uniform intervals shorter than the panel-lengths, these floorbeams being carried by the riveted lower chords of the trusses. This arrangement allows

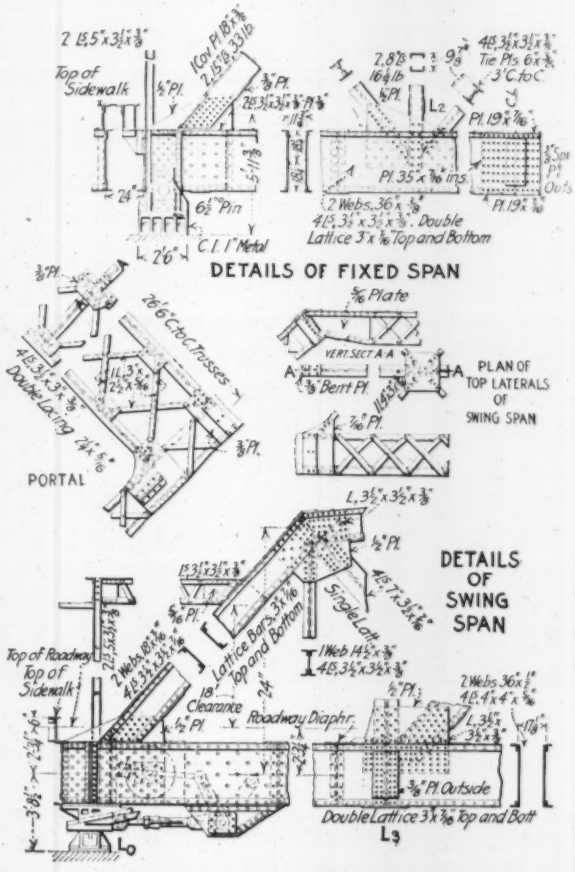


Fig. 1. Type of Details of Fixed and Swing-Spans, Congress St. Bridge

the use of a very shallow floor with floor panels of such proportions that rolled-beam stringers can be used with economy. It also makes all floorbeams alike, even where panel-lengths vary, and does away with the necessity of complicating the connection of web members by having the floorbeams attached at the main joints.

On the swing-span a riveted lower chord is required in any event, and on the fixed truss-spans the additional metal used to make the lower chords stiff does not equal the metal otherwise saved in this arrangement of floor; so the saving of weight by such a floor system is considerable. The details in Fig. 3 show how the chord is constructed and explain its web connections and the floorbeam attachment.

Floor and Paving—The sidewalks on the fixed spans are of reinforced concrete and the roadway paving of wood block on reinforced-concrete slabs. On the swing-span, however, concrete sidewalks and roadways would cause an excessive weight, so the sidewalks are here made of

*Boller, Hodge & Baird, Consulting Engineers, 149 Broadway, New York.

2-in. plank and the wood-block roadway surface is laid on a 5-in. splined creosoted-plank base, covered with a five-ply tarred-felt covering, the wood block being bedded in a ⅛-in. coating of hot pitch and sand.

sheathed with 16-oz. copper. At each end of the approaches are ornamental portals consisting of Bedford limestone ashlar pillars connected overhead by a wrought-iron ornamental grill.

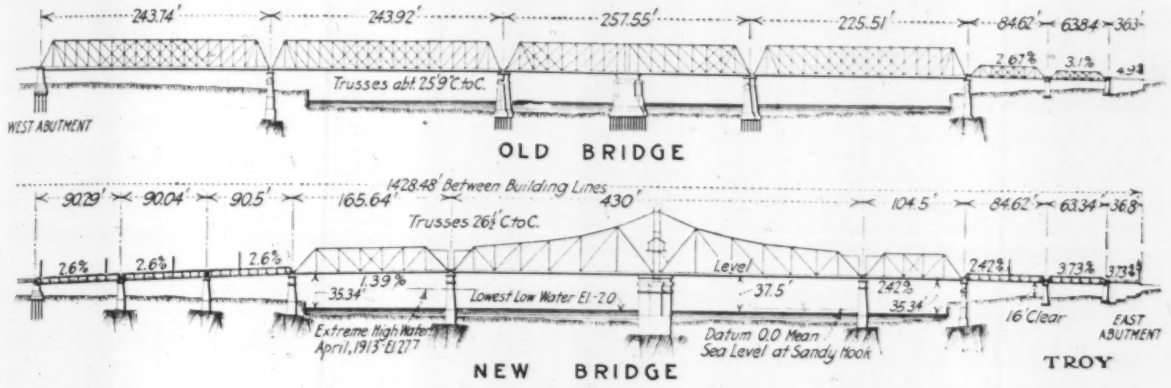


FIG. 2. GENERAL ELEVATION OF TRUSS-SPANS, NEW BRIDGE OVER HUDSON RIVER AT TROY, N. Y.
(Part of old truss-span also shown)

The trolley rails on all spans are fastened directly to diaphragms between double-channel stringers.

The paving of the filled approaches is of 5-in. granite blocks on an 8-in. concrete base, and the trolley rails are attached to steel channel ties bedded in the concrete while

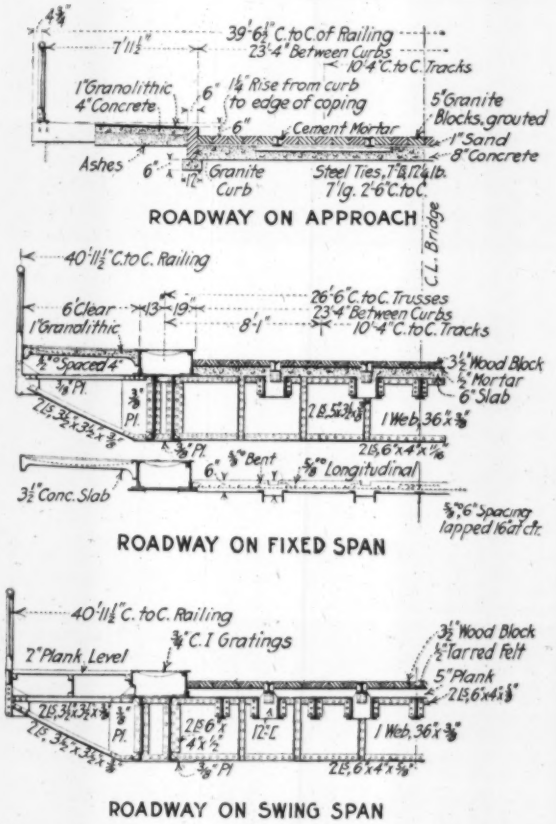


FIG. 3. ROADWAY CROSS-SECTIONS, CONGRESS ST. BRIDGE

wet. The granite blocks are to be cut to a smooth surface and grouted in place with a 1:1 cement grout.

The three roadway sections in Fig. 3 explain these different constructions more fully.

The operator's house and the toll-houses are fully

The bridge was designed by the writer's firm for the Troy & West Troy Bridge Co. The Fort Pitt Bridge Works has the contract for the entire structure and J. H. Gray is building the substructure for them.

Progress in Refuse Disposal

In a lengthy paper on refuse disposal presented by Col. Wm. F. Morse before the Jacksonville meeting of the American Public Health Association in December, 1914, some interesting figures were given on the progress in the last fifteen years in disposal by burning and by reduction.

At the close of 1914 there had been built in the United States and Canada 296 municipal incinerating plants.* Of these, 88 were built from 1908 to 1914.

A notable feature of the later installations of refuse-burning plants has been that they have been of the high-temperature type. In 1908 there were only four high-temperature plants—at Westmount, P. Q., Vancouver, B. C., Seattle, Wash., and New Brighton, N. Y. (New York City). In November, 1914, there were 29 separate high-temperature incinerators, located in 24 cities in the United States, Canada, and Cuba. Most of these were built in 1911 to 1914 inclusive.

As to the use of power in connection with high-temperature plants, Mr. Morse states:

> At Buffalo power is employed for pumping sewage; at Montgomery, Ala., for pumping water; at Seattle for use in private manufacturing plants which pay a revenue to the city.† At Boston the plant is operated for utilization purposes, and the surplus heat is used in the adjoining reduction plant. At Milwaukee, by the aid of electrical equipment, power is proposed to be used for pumping water. At Westmount both plants utilize their power for electric lighting of the city. At Savannah the power is employed for pumping water. At Columbus the power will be used for municipal service. All other installations, so far as is known, have not as yet been able to utilize the heat derived from the destruction of waste for municipal purposes.

*How many of the 296 plants which had been built in the United States and Canada were actually in operation in 1914 Mr. Morse's paper does not state.—EDITOR.

†Apparently Mr. Morse did not know, or at least he did not state, that two of the three plants at Seattle have been shut down. The use of steam commercially from the Milwaukee plant does not appear to have been successful as yet. The incinerators at Buffalo, Boston and Columbus burn tailings from rubbish-utilization plants. There is a similar plant, not mentioned by Mr. Morse, at Pittsburgh, Penn.—EDITOR.

The use of high-temperature incinerators has been restricted chiefly to the larger cities on account of their high initial cost. Although more will be built, Mr. Morse aptly says:

> It appears to be only reasonable to expect that hereafter there will be devised a simpler form of destructor, better adapted to American conditions, to be built at much less initial cost, operating at less expense, and designed almost solely for disposal, without reference to the employment of steam.

From Oklahoma alone three designs for low-cost furnaces have come. That these are not promising appears from the following extract from Mr. Morse's paper:

> These the promoters claim in their advertising pamphlets to be "odorless," to be able to "burn coke or coal," and to be entirely "sanitary." These furnaces are very simple in design—being in one case a construction much like an enlarged Dutch oven, with removable frame or platform which is run into the furnace, loaded with refuse, which is consumed by heat from the firebox inside of the furnace, the flame passing over the material through a stack on the opposite side. The method by which these furnaces are sold is to offer to build a construction of comparatively moderate size, to operate this by the contractor's own employees for one trial, and to demonstrate that a quantity of garbage and refuse can be destroyed within a certain time. . . . It does not seem probable that this method of destroying mixed city waste can succeed in obtaining a permanent foothold.

The total number of reduction plants in 1908 in the United States was 34. All these, except the one at Cleveland (which has since been bought by the city), were privately owned and operated. In November, 1914, a total of 45 reduction plants had been built, of which 22 were then in use. A new privately owned reduction plant is being built at Los Angeles, Calif. Four municipally owned plants were in operation in November, 1914—Chicago, Cleveland, Columbus, and Schenectady; one was under construction at Akron, Ohio; two were proposed, on each for Detroit and Dayton.

Of 52 reduction plants built, under construction or proposed, only 30 are now in existence as plants or projects.*

*The fact that nearly all the reduction plants have been privately built, under short-term contracts, probably accounts for shutting down of them.—EDITOR.

Philadelphia Water-Filter Operations in 1914

Tabular summaries of the operations of the filtration plants of the Philadelphia water-works for the year 1914 have been made up in accordance with the standard forms devised by a committee of the New England Water-Works Association.* We are indebted to C. E. Davis, Chief of the Bureau of Water of Philadelphia, for advance copies of the summaries. The entire water-supply of Philadelphia, it may be explained, is filtered by slow sand filters, and most of it is prefiltered. There are five plants: One large one at Torresdale, on the Delaware, and four smaller ones, filtering Schuylkill River water.

The New England standard filter-statistics summary

*Prof. Geo. C. Whipple, of Cambridge, Mass., and New York City, was chairman of the committee, and Francis D. West, Chemist of the Torresdale Filtration Plant of the Philadelphia Water-Works, was one of the other members. The committee's report was submitted to the December, 1914, meeting of the association. After discussion at the meeting on March 10, 1915, the committee was continued.

TABLE I. OPERATING COSTS OF PHILADELPHIA FILTERS, 1914

	Upper Roxborough		Lower Roxborough		Belmont		Queen Lane		Torresdale	
	1913	1914	1913	1914	1913	1914	1913	1914	1913	1914
Prefilters	.....	.....	$5,185	$6,129	$9,399	$8,705	$3,192	$3,149	$15,137	$14,814
Final filters	$14,872	$14,108	12,223	11,062	38,242	41,722	42,764	44,282	117,643	134,153
Total cost	$14,872	$14,108	$17,408	$17,191	$47,641	$50,427	$45,956	$47,431	$132,780	$148,967
Million gallons filtered	4,443	4,674	2,998	3,364	13,288	13,884	17,792	17,948	68,538	66,612
Cost million gallons	$3.35	$3.02	$5.80	$5.10	$3.58	$3.62	$2.57	$2.65	$1.93	$2.23

TABLE II. METHODS OF OPERATION OF FINAL FILTERS, PHILADELPHIA WATER-WORKS, 1914

	Quantity Filtered, Million Gal.		Rate per Acre per Day		Av. No. Cleanings per Filter	Av. Days in Service Between Cleanings	Av. No. Cleanings per Filter by			Av. No. Rakings Between Cleanings
	Total	Ag. Av.	Av., Entire Area	Max., Area in Service			Nichols' Method	Brooklyn Method	Ejecting	
Torresdale	66,611.585	182.498	3.668	4.761	4.60	73.04	4.46	0.14	....	2.00
Queen Lane	17,948.475	49.174	3.054	4.224	1.86	201.33	1.86	....	....	1.68
Belmont	13,884.485	38.040	2.977	4.159	7.12	48.43	1.06	6.06	....	0.37
Upper Roxborough	4,673.968	12.805	2.287	3.615	6.00	58.36	0.63	5.38	....	0.19
Lower Roxborough	3,363.920	9.216	3.478	5.531	10.6	33.44	1.00	9.60	....	0.09

TABLE III. CHEMICAL AND MICROSCOPICAL CHARACTER OF DELAWARE RIVER WATER

(Parts per Million)

1914	Chlorine	Total Solids	Total Hardness	Alkalinity Average	Alkalinity Maximum	Alkalinity Minimum	Free CO_2	Dissolved Oxygen	Iron	Suspended Matter	Oxygen Consumed	Micro-Organisms Number per C.C.	Micro-Organisms Standard Units per C.C.
Average	5.1	119	55	31			4	9.8	1.58	34	3.35	467	656

TABLE V. TURBIDITY AND COLOR OF DELAWARE RIVER WATER

(Parts per Million)

	Turbidity								Color						
	No. of	Mean	Variations: No. of Test Days						No. of	Mean	Variations: No. of Test Days				
1914	Test Days	Turbidity	0 to 10	11 to 25	26 to 50	51 to 100	101 to 250	251 to 500	Above 500	Test Days	Color	0 to 10	11 to 20	21 to 50	51 to 100	Above 100
Total	365		159	146	40	7	12	1		52			51	1		
Average		20.2									15					
% time			44	40	11	2	3	0.3					98	2		

Note: Maximum daily average turbidity, 400. Maximum, single test, turbidity, 520.

TABLE IV. CHEMICAL CHARACTER OF WATER IN EFFLUENTS FROM TORRESDALE PLANT

Parts per million

1914	Chlorine	Hardness	Alkalinity Average	Alkalinity Min.	Iron	Oxygen Consumed	CO_2	Dissolved Oxygen
Jan.	5.0	62	23	19	0.28	1.65	2	13.3
Feb.	4.7	44	21	15	0.37	1.70	3	13.3
Mar.	4.6	43	21	11	0.17	1.70	3	13.1
Apr.	3.1	31	12	10	0.14	2.00	3	10.8
May	3.0	36	17	16	0.06	2.05	6	8.8
June	4.5	56	33	27	0.02	1.50	7	7.1
July	5.6	57	34	28	0.06	1.80	7	6.9
Aug.	5.0	60	37	34	0.04	1.30	8	6.9
Sept.	5.4	57	38	34	0.03	1.20	6	7.8
Oct.	8.5	74	49	46	0.06	1.10	5	8.6
Nov.	7.7	81	51	49	0.06	1.35	5	10.7
Dec.	5.6	64	34	24	0.10	2.00	3	13.2
Average	5.2	55	31		0.12	1.60	5	10.0

TABLE VI. TURBIDITY OF APPLIED WATER—FINAL FILTERS—TORRESDALE

(Parts per Million)

			Variations: No. of Test Days						
1914	No. of Test Days	Mean Turbidity	0 to 10	11 to 25	26 to 50	51 to 100	101 to 200	Above 200	Per Cent. Rem.
Total	365		289	56	5	10	4	1	
Average		9.5							
% time			79	15	1	3	1	0.3	

Note: Maximum daily average, 300. Maximum single test, 400.

includes two general tables of operating costs and methods, and a number of tables reporting monthly averages of analyses of the water before and after filtration. We reprint in full the two general tables for all five of the filtration plants at Philadelphia. Of the other tables we omit those for the four Schuylkill plants and choose the Torresdale tables to illustrate further the New England forms and to present the analytical results at Philadelphia. Lack of space also compels us to omit the monthly averages from some of the tables.

TABLE VII. TURBIDITY AND COLOR OF WATER IN EFFLUENTS FROM TORRESDALE PLANT

(Parts per Million)

	Turbidity					Color					
			Variations: No. of Test Days					Variations: No. of Test Days			
1914	No. of Test Days	Mean Turbidity	0	0.5 to 5	Above 5	No. of Test Days	Mean Color	1 to 10	11 to 20	21 to 50	Above 50
Total	365		300	57	8	52		41	11		
Average							10				
% time			82	16				79	21		

Note: Maximum turbidity, 14. No. of tests above 1, 15.

TABLE VIII. NUMBER OF BACTERIA IN DELAWARE RIVER WATER

	Number of Bacteria on Gelatin at 20° C.									Bacillus Coli						
				Variations: No. of Test Days							0.01 C.C. Tests		0.1 C.C. Tests		1.0 C.C. Tests	
1914	No. of Test Days	Mean per C.C.	Median per C.C.	0 to 100	101 to 300	301 to 1000	1001 to 10,000	10,001 to 100,000	Above 100,000	No. of Test Days	Total No., +	% +	Total No., +	% +	Total No., +	% +
Jan.	31	34,000	24,000	0	0	0	6	23	2	12	1	8	12	100	12	100
Feb.	28	17,000	13,000	0	0	0	10	18	0	11	1	9	9	82	11	100
Mar.	31	22,000	13,000	0	0	0	11	20	0	14	0	0	2	14	14	100
Apr.	30	4,900	3,600	0	0	0	27	3	0	13	0	0	1	8	13	100
May	31	6,000	3,800	0	0	0	28	3	0	12	0	0	3	25	12	100
June	30	4,800	3,500	0	0	2	25	3	0	14	3	21	12	86	14	100
July	31	12,000	9,000	0	0	0	15	16	0	13	2	15	12	92	13	100
Aug.	31	7,000	6,900	0	0	0	25	6	0	13	1	8	12	92	13	100
Sept.	30	2,900	2,500	0	0	1	29	0	0	13	5	38	13	100	13	100
Oct.	31	3,200	2,500	0	0	2	29	0	0	12	4	33	12	100	12	100
Nov.	30	6,200	5,000	0	0	0	25	5	0	13	5	38	13	100	13	100
Dec.	31	80,000	60,000	0	0	0	1	20	10	14	2	14	14	100	14	100
Total	365			0	0	5	231	117	12	154	24		115		154	
Average		16,800	5,500									16		75		100
% time						1	63	32	3							

Median for year, 5500.

TABLE IX. NUMBER OF BACTERIA IN EFFLUENTS FROM TORRESDALE PLANT

	Gelatin at 20° C.								Agar at 37½° C.							
				Variations: No. of Test Days								Variations: No. of Test Days				
1914	No. of Test Days	Mean per C.C.	Median per C.C.	0 to 10	11 to 25	26 to 50	51 to 100	100 to 250	Above 250	No. of Test Days	Mean per C.C.	Median per C.C.	0 to 10	11 to 25	26 to 50	51 to 100	Above 100
Total	364			234	54	21	16	20	19	357			223	99	23	12	0
Average		51									12						
% time				64	15	6	4	6	5				63	28	6	3	0

Median for year, 7. Median for year, 8.

TABLE X. COMPARISON BETWEEN BACTERIAL COUNTS ON GELATIN AND AGAR, AT TORRESDALE

(Bacteria per Cubic Centimeter)

1914	Av. Temp. Deg. F.	Delaware River Gelatin	Delaware River Agar	*Effluent of Filters Gelatin	*Effluent of Filters Agar	†Filtered-Water Basin Gelatin	†Filtered-Water Basin Agar
Jan.	36	34,000	.....	750	.....	230	26
Feb.	36	17,000	890	160	35	99	25
Mar.	35	22,000	350	300	27	27	19
Apr.	51	5,000	260	89	17	12	14
May	59	6,000	2400	43	19	12	13
June	72	4,800	3700	24	19	5	5
July	75	12,000	6900	34	42	9	7
Aug.	76	7,000	6000	42	30	5	6
Sept.	70	2,900	3800	20	20	4	5
Oct.	62	3,200	4600	29	35	4	3
Nov.	48	6,200	1600	65	23	5	4
Dec.	36	80,000	1500	1100	68	200	16
Average	55	16,800	2900	246	30	51	12

*Treated with liquid chlorine. †Untreated. Gelatin, 48 hr. at 20° C. Agar, 24 hr. at 37½° C.

Teaching Human Engineering

By Fred H. Rindge, Jr.*

Why did the United States Steel Corporation spend $7,000,000 in "industrial betterment" last year? Why are hundreds of other business and commercial organizations spending large sums of money in accident prevention, sanitation, education, recreation, proper housing, etc., for their employees? Because it pays in dollars and cents and because it is the right and "human" thing to do.

Still more significant is the growing realization that our future industrial leaders must be men with a sincere interest in this human side of their profession. Many of our industrial leaders have come from our colleges and technical schools. To what extent did they have instruction and practical experience which helped them to an appreciation of the human side? Business men are insisting more than ever before that our colleges and engineering schools must accept responsibility in developing these qualities in men.

In the Nov. 13, 1913, issue of Engineering News I described briefly how the Industrial Service Movement is helping solve the problem. In seven years the Movement has spread to two hundred colleges. At present more than 3500 engineering students are engaged each week in many forms of service which affords personal contact with the kind of industrial workers with whom they will later deal, directly or indirectly. Men teach foreigners English and citizenship by a method especially devised so that they need not know the language of their men. They instruct American workingmen in mathematics, mechanics, mechanical drawing, blueprint reading and other technical subjects. They lead clubs and other activities for working boys. And it is all in the spirit of service and not of superiority.

Just what does the coming engineer learn as he mixes with industrial men in a friendly way? He learns that all men are men regardless of race, nationality, color or creed, but that men must be dealt with very differently; he learns that it pays to win the leaders of men if one desires to win the men themselves; that the work, home and leisure life of industrial workers play a large part in determining efficiency; that a man's shop associates may largely influence the quality of work he does; that helping men to concentrate on their work (though not at the expense of mental and physical welfare) increases output; that friendly competition (without driving men) helps break records; that reasonable relaxation and recreation pays both from the human and economic standpoints; that loyalty of the men is one of the employer's greatest assets; and that character counts most of all. More than this, he

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learns in general to understand men, he learns how to sympathize with the other fellow's point of view and how to handle men successfully. Surely all this is part of an engineer's equipment for life.

This practical service is only one of the many activities promoted by the Industrial Service Movement. The country has been divided by territories and special speakers have been secured for the colleges of each territory. Successful employers, engineers, labor men, social workers and others give special addresses on human engineering, industrial betterment and kindred topics. An industrial-service reference library and articles in college publications maintain interest. At the close of each year special meetings of the seniors are held and arrangements made to coöperate with the interested men after graduation.

One graduate writes: "I owe my present position to the class of foreigners I taught while at college. My interest has grown each year since, and I now have charge of all the educational work in our company." We hear constantly from young technical graduates who are accomplishing remarkable results. One man has put up a $30,000 club house for his employees, another has become an expert in accident prevention, and another is secretary of an educational committee in a large city.

It is significant that the national engineering societies are expressing active interest in this Movement. At the June, 1914, meeting of the American Society of Mechanical Engineers, Prof. J. W. Roe, of Yale, read a paper about the Movement, in which he said:

> The development and application of the highest types of industrial management are going to be difficult and delicate work, if the results are to be made a permanent benefit to society as a whole. Those who personally direct this development will largely determine the efficiency with which "efficiency" itself is applied. If the attempt is made by those in charge to seize all the benefit of the improved methods and to crowd the advantage of the employer, they will either defeat or indefinitely postpone the advance. They must be experienced men, wise, fair, thoroughly conversant with possibilities and free from sentimental idealism. This means not only a knowledge of machinery, systems, and time study, but of human nature and the rights and real needs of industrial workers.
>
> The executive engineer will be at the focus of this situation. He alone is in direct personal contact with the two great elements involved, capital and labor. His thorough understanding of both of these forces will prove one of the greatest elements in progress.

A Balanced Cantilever Reinforced-Concrete Bridge*

By Henry H. Quimby†

There was constructed and opened to travel about a year ago a bridge that is believed to be of a new type, and that is of interest as such, besides presenting a means of obtaining a much desired class of structure where otherwise it would be impracticable. The design as worked out proved to be economical in cost of construction, and the bridge is quite rigid under traffic and is an admired ornament to the locality.

In appearance it is a concrete arch, but in reality is composed of two balanced cantilevers which are theoretically independent of each other in action, being connected simply by a short suspended span over the channel, each cantilever being in itself stable over a single pier without assistance from the other, and without anchorage.

The bridge is in the city of Chester, Penn., carrying Fifth St. over the Chester River. Its length is 160 ft. over all, with main span of 95 ft. c. to c. of piers, and wings or shore overhangs of 31 ft. and 34 ft. respectively. It is 60 ft. wide, with cartway of 36 ft. between curbs.

The peculiar design was adopted because of the desire of the authorities for not only an open deck but an ornamental arch bridge at this point, while the sub-surface conditions were such as would make a real arch very costly to construct. Also as the river is navigated past this point it was desirable to have a thin floor at the middle of the channel without humping up the street grades.

These subsurface conditions consisted of deep soft mud on one side of the river with the hard rock bottom sloping steeply away from the channel, so that even if an arch abutment had been carried down to it skewback steps would have to be cut in it to prevent sliding with the thrust of the arch, and the character of the rock was suspected, because of the structure of outcroppings in the neighborhood, to be seamy and untrustworthy for dependence against sliding. Also, the authorities that paid for the bridge are not the local municipal government, and are by law restricted in their jurisdiction and respon-

*From a paper presented at the December meeting of the American Association for the Advancement of Science.

†Chief Engineer, Dept. of City Transit, Philadelphia, Penn.

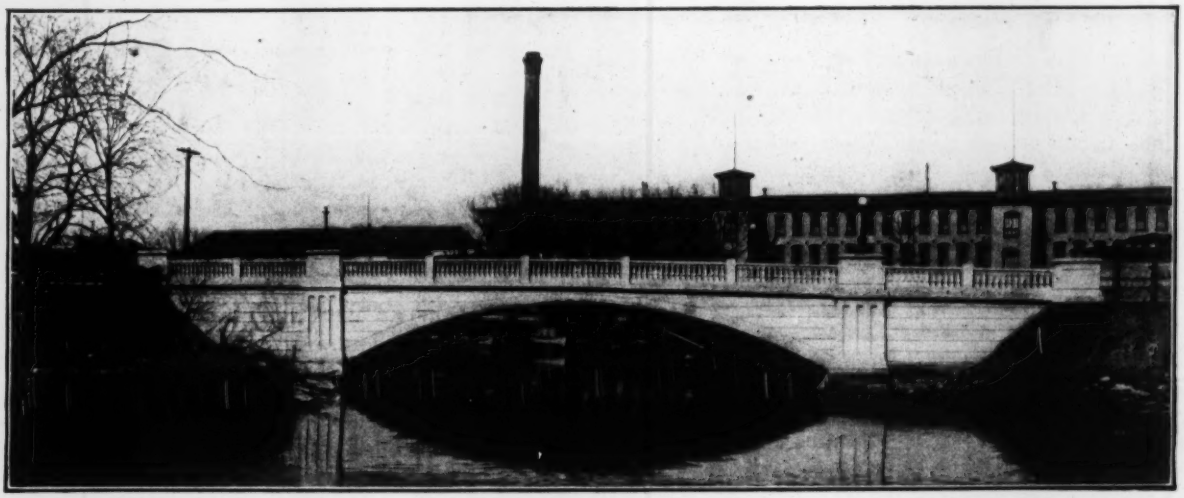

Fig. 1. The Fifth St. Bridge, Chester, Penn.; a Balanced Cantilever Not an Arch

sibility to the extremities of any bridge that they construct. Therefore they were not responsible for either the construction or the maintenance of the street approaches to the bridge and were not called upon to provide retaining walls beyond the bridge proper to maintain the banks of the approaches. This consideration is of importance because the stream bends so as to flow nearly parallel with the street on one side, and a retaining-wall abutment wing, to be of use as such, would have had to be very long and in the deep mud would have been very expensive.

The bridge was built by the authorities of the County of Delaware, and the approaches, which are the bed of Fifth St., are within the jurisdiction of the authorities of the city of Chester, which is in Delaware County.

curs with the greatest concentration on the extreme end of a wing when there is no live load on the span.

Loads—The structure is designed for heavy street loads—two street-railway tracks each covered with 50-ton cars and vehicle loads on the shoulders averaging 100 lb. per sq.ft. or concentrated to 15 tons per axle. The sidewalks were designed in contemplation of the possibility, not infrequently realized, of an automobile leaving the cartway and traversing the sidewalk. The floor of the cartway is of concrete jack arches turned between the ribs, and the sidewalks are rod-reinforced-concrete slabs.

Footings—The deep mud on the east side of the river called for pile foundations to the pier on that side, while on the west side the rock is so near the surface that a thin concrete bed laid on it was all that was needed.

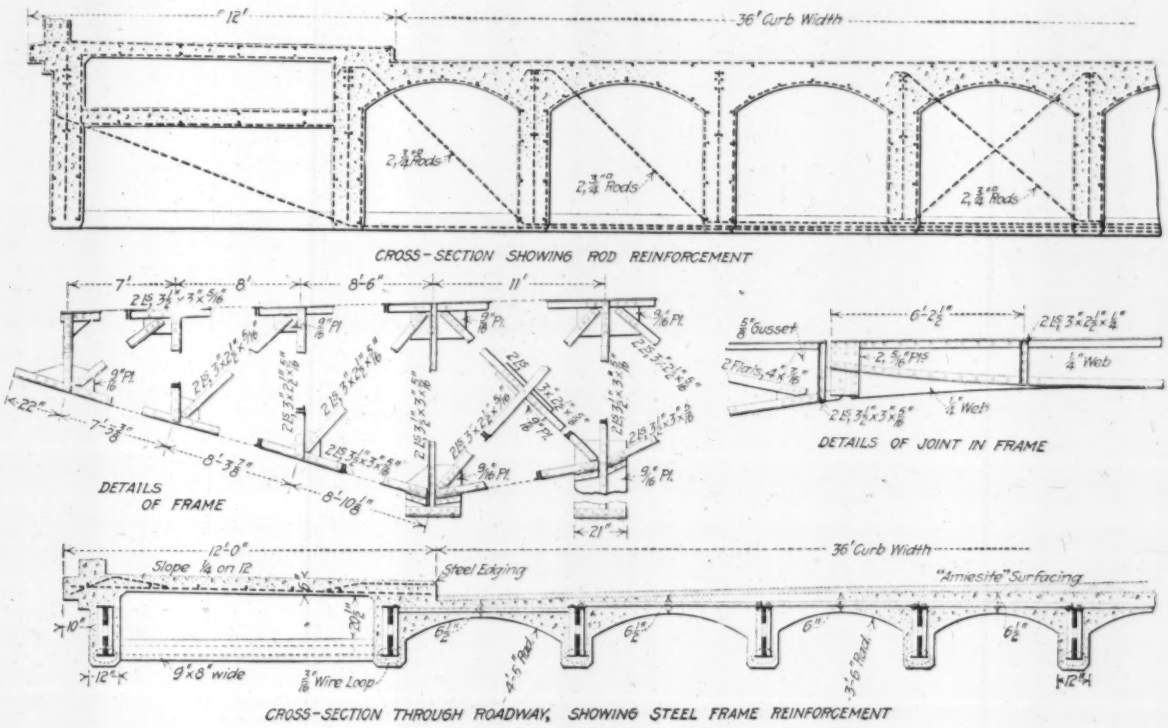

Fig. 2. Details of the Fifth St. Bridge

The principle of the balanced cantilever is that of the double cantilever gantry crane, where the load travels from one side to the other of the support, the varying position of the live load shifting the center of the gross pressure on the pier to one side or the other of the middle of the pier. If the range of shift is not more than one-third of the width of the support—one-sixth either way from the center—there will not be any uplift or tension at the edge, and the extreme intensity of pressure on the loaded edge will not be more than twice the average over the whole width, and the heavier the dead load is in proportion to the live load the less the eccentricity of the combined load can be. This bridge was designed so that the dead load balances just at the middle of each pier with equal moments from both sides, and the greatest possible eccentricity of live load either on the wings alone or on the span alone will shift the center of gravity of the combined live and dead less than the limiting one-sixth of the width. The maximum eccentricity oc-

The foundation concrete in each pier was regarded as dead weight and was anchored to the superstructure with embedded vertical steel rods to get the benefit of its effect on the shifting center of gravity of the mass.

The east pier was made 16 ft. wide in the direction of the axis of the bridge to insure a width three times as great as the shift of the center of pressure on it. The piles, which were of wood, were driven to rock, but because of the softness of the mud stratum and the shallowness of the gravel over the rock, the loading of the piles was limited to 16 tons per pile of the outer rows under greatest eccentricity. Spur or batter piles were driven on both sides and both ends to prevent lateral displacement, but they were not assumed to carry any vertical load.

The mud, being soft, gives very little lateral support to the piles, which therefore became unbraced columns. In order to give them fixity at the top and reduce their tendency to buckle under load the concrete capping was

cast around the upper 3 ft. of their length, and it was tied to them with embedded steel rods hooked around the outer piles to prevent the concrete cracking away on the line of the outer row.

STRUCTURAL DETAILS—The concrete ribs are ten in number and are 12 in. thick, and are reinforced with steel—both riveted structural members and embedded rods in combination. The riveted trusses were made only strong enough to carry the weight of the forms and the soft concrete of the ribs, no falsework being used on the job. The rods comprised nearly one-half of the tension reinforcement of the ribs.

Transverse diaphragms of concrete 6 in. thick, reinforced with rods, were cast at four points in the span to act as distributors transversely of concentrated loading, and the counterweights at the ends of the wings, which are 3½ ft. thick, are reinforced in the same way and for the same purpose as well as for the purpose of suspending them from the ribs. They were designed so that the load from one street-car track will be distributed over four ribs, or the load of the two tracks distributed to and carried by the eight interior ribs. Transverse walls 2 ft. thick along each edge of each pier serve to complete the lateral distribution if any more should be needed. The diaphragms are useful also as diagonal braces for the ribs.

The ribs are spaced so as to take the rails of either one track or two tracks, and only vehicle traffic will come on the jack arches, which have a crown thickness of 6½ in. Their thrust is transversely of the bridge and is resisted by structural-steel ties at intervals across the whole width, the sidewalk slabs acting as horizontal beams in gathering the thrust to the ties.

The suspended span between the two cantilevers consists of a 20-ft. length of one of the cantilevers. It is therefore continuous with it and in fact is suspended only from the other cantilever. This continuity of the flanges modifies to some extent the cantilever action, but it does to only a very limited extent and was designed to contribute to rigidity. In placing the trusses in erection they were adjusted on their bearings so as to divide the initial load of the suspended span equally between the two cantilevers. This was accomplished by wedging under the east trusses, which were the continuous ones, until the weight of the ends resting on the seats at the ends of the west trusses was one-half of the weight of the suspended span, as determined by testing with a lever of convenient proportions.

The concreting of the ribs was done in two stages, a pair of steel rods being embedded at the top of the first stage in each rib to create preliminary cantilevers that absorbed initial stress from the subsequent concreting, and did so at a point that does not get the maximum stress from full load. Care was taken in placing concrete to keep the growing load approximately symmetrical over the piers.

As the lower edges of the ribs are compression members, and the river craft are heavy barges floated up and down stream on the tide, which runs fast at this point, it was desirable to protect the ribs against collision, and this was done by constructing a 6-in. rod-reinforced-concrete slab sheeting between the ribs halfway up from the spring,

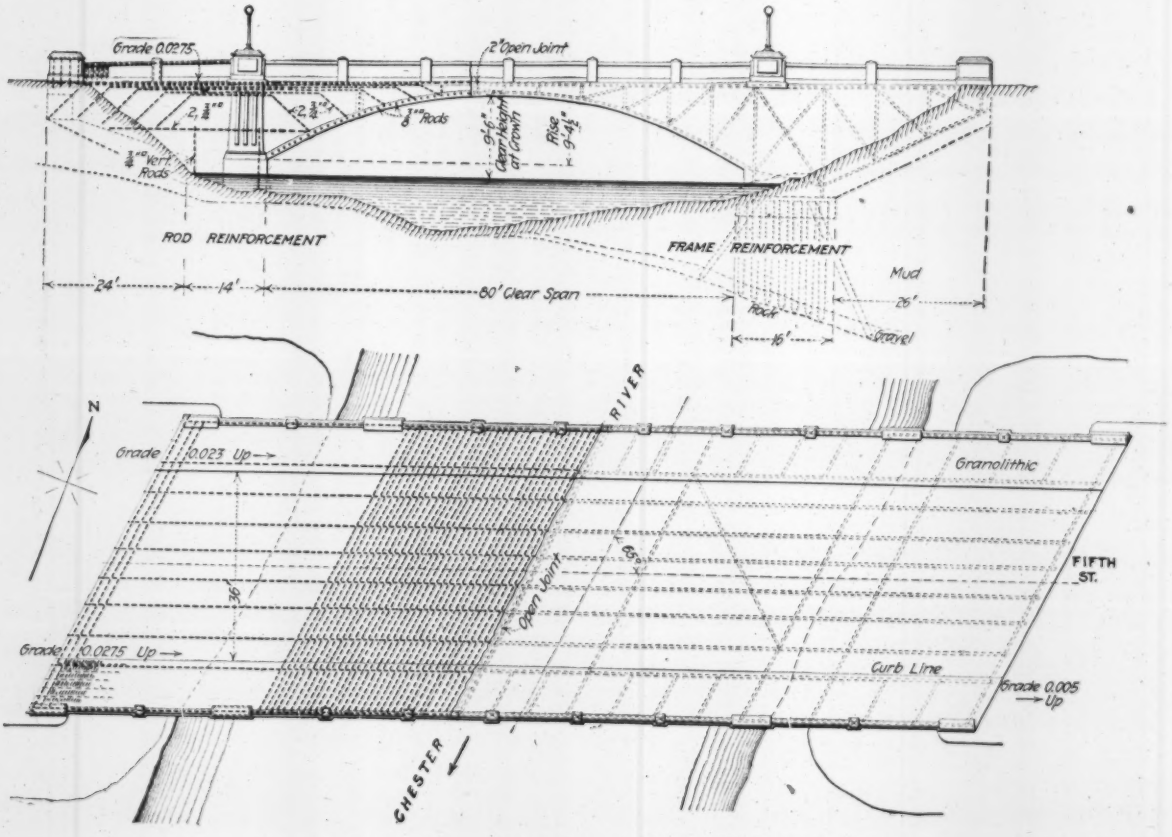

FIG. 3. FLOOR SECTIONS OF FIFTH ST. BRIDGE

FIG. 4. REINFORCEMENT IN PLACE; FIFTH ST. BRIDGE, CHESTER, PENN.

making a smooth soffit that the corners of scows cannot engage and that also very effectively braces the ribs.

The parapets are open balustrades of concrete faced with a fine concrete or granolithic mixture which was finished by scrubbing with brushes and water when only partly hardened. The texture and tone that resulted resemble hammer-dressed granite, and the surface is not subject to either hair-cracking or efflorescence or discoloration and is rough enough to discourage the practice of penciling on it by idlers.

A gallery space was constructed under each sidewalk for the accommodation of water and gas mains and electrical conduits.

THEORY OF DESIGN—The theory of the design of this bridge is that the two cantilevers are independent, and the construction carried out the theory by leaving an open joint in the floor where the two ends came together, but apparently the push of the earth fill against the piers holds the joint tightly in contact and produces a certain amount of real arch action in the arched span. The joint has not opened so much as a visible crack even in the coldest weather. It was made by lapping gussets between the ends of the trusses and bolting through slotted holes to permit movement in temperature changes. Heavy steel angle dams were provided against which to finish the floor concrete. It would seem from the experience here that the joint with play for movement was an unnecessary refinement in the design and might have been omitted.

Even if the pressure of the filling against the ends were not existent, and in consequence some tension were to develop across the span in cold weather, no harm could result from complete continuity of flanges, for the only effect would be a fractional change of stresses in the rib with a slight increase in the computed maxima. Besides, under such a condition of no end pressure the continuity of both flanges would contribute to rigidity under moving loads. The maximum tensile stresses in the ribs occur under full live load, and any pulling force across the channel would first operate to neutralize the compressive stress in the cantilevers, and such tension as would actually develop would be only in the nature of initial stress which would be almost wholly absorbed by normal load stress. Therefore it would seem to be safe and desirable as well as economical to rivet up the flanges and omit the joint in the floor.

A cantilever is inherently more flexible and less rigid than a braced arch or than even a simple truss, because the flange stresses are acting throughout a longer line with consequent greater stretch and greater shortening of flanges, for the same reason that a long beam will deflect more than a short beam under the same fiber stress.

Also, in the case of this bridge the transit of the center of gravity forth and back from one side to the other of a pier constitutes a rocking force, and might be expected to appear as an influence causing some horizontal movement in the pile pier. There is, however, no perceptible effect under the loads to which it has as yet been subjected and the structure is as rigid as a real arch.

PERSONNEL—The bridge was designed for and built by Commissioners Geo. W. Allen, J. D. Pierson and T. F. Feeley of Delaware County, Pennsylvania, and the contractor was Carl R. Camp.

The contract price of the bridge was $33,000, or $3.43 per sq.ft., the contract having been made at the time when the cost of construction material and labor was at the highest point.

A Modern Rock-Crushing Plant

By Preston K. Yates*

SYNOPSIS—Improvements in machinery for quarrying, crushing and transporting broken stone have well nigh revolutionized the business of crushed-stone production. A newly opened trap-rock quarry, equipped with the latest appliances for crushing and handling broken rock, is here described by its designing and constructing engineer.

Most of the crushed trap rock for the supply of New York City and vicinity has hitherto been obtained from the great deposits of trap rock on the western bank of the Hudson River. Fifteen years ago the States of New York and New Jersey joined in a movement to stop the injury to the Hudson River scenery by the operation of the quarries, and created the Palisades Interstate Park Commission with authority to condemn and acquire the quarry properties. The Commission now controls the entire river frontage for the length of the Palisades, some 15 miles, and at Hook Mountain, 35 miles north of the city, which has been in recent years the chief source of trap rock supply, the Commission has now acquired and closed all the trap rock quarries save one, on which condemnation proceedings are in progress.

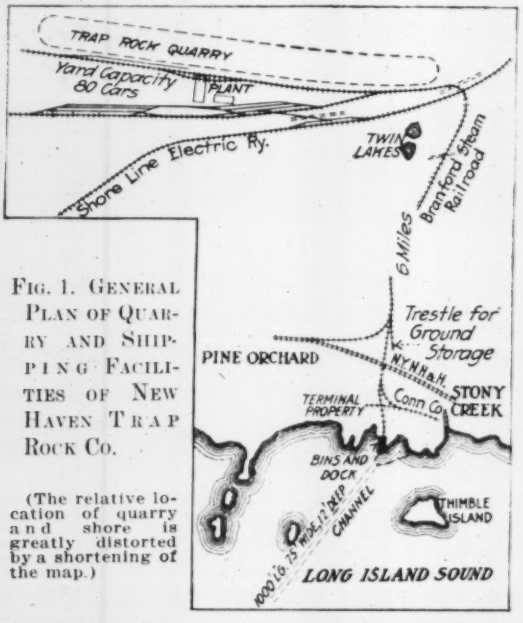

FIG. 1. GENERAL PLAN OF QUARRY AND SHIPPING FACILITIES OF NEW HAVEN TRAP ROCK CO.

(The relative location of quarry and shore is greatly distorted by a shortening of the map.)

The closing of these nearby sources of trap-rock supply has made possible the development of more distant sources. A project which originated many years ago to develop a great deposit of trap rock in southern Connecticut has within the past year been carried into effect. At North Branford, Conn., nine miles east of New Haven, the New Haven Trap Rock Co. has opened quarries and created a stone-crushing plant and shipping facilities which will doubtless become one of the largest crushed-stone enterprises in the United States.

Totoket Mountain, on which the trap-rock deposit occurs, is a broad plateau several miles in length, on which an underlying stratum of sandstone is covered with a sheet of trap rock 150 ft. or more in depth. The company has acquired title to 600 acres of land for its quarry property; and if the marketable trap rock on the tract be estimated at no more than half a million tons per acre, it is readily seen that the quarry is practically inexhaustible.

A year ago the writer was placed in charge, as chief engineer and general manager, of the work of developing this quarry and creating facilities for crushing the rock and shipping it to market. The general plan of the entire operation is shown in the accompanying sketch map, Fig. 1. The trap-rock deposit which forms the top of the mountain is covered with but a thin layer of soil. The face of the hill for a long distance is very abrupt. Along this steep slope a quarry face has been opened some 5000 ft. in length and 50 ft. in height. The trap of Totoket Mountain shows the columnar formation to a remarkable extent; and when lifted by a blast, it breaks up into fragments of small sizes, leaving very few chunks so large that they require dobey shooting in order to be handled by a steam-shovel dipper.

In working this quarry face, the present practice is to drill horizontal "snake" holes at the quarry floor about 30 ft. deep and 10 ft. apart. After springing the holes, they are charged with 60% dynamite. About twenty holes are loaded and fired at one time, lifting an area of ledge about 200 ft. long and 30 ft. in depth back of the working face. Instead of the horizontal drill holes, well drills may be used on the top level. Steam from portable boilers is now used for drilling, but the quarry may eventually be equipped with compressed air.

As the face has now been developed, there are two distinct quarries, so that if one is shut down to extend track or for other reasons, the other quarry may keep up the supply of rock to the crushers. The plan of operation is to take off a layer of rock 50 ft. in height over the entire area. Another quarry floor will then be opened on a level 50 ft. lower and the operation continued as before.

Steam shovels load the blasted rock into side-dump steel cars of standard gage and about five-ton capacity, and as fast as a train of these cars is loaded it is taken to the crusher plant over a 2% down grade by 45-ton locomotives.

The crushing plant is built on the steep side-hill slope below the quarry level. The steep slope was a great advantage as it made possible the flow of the rock by gravity through the crushing house. The soft sandstone of the side hill was excavated until a series of benches was formed; heavy concrete retaining walls were built at the sides, and on these walls was erected the steel-frame superstructure which, besides carrying the roof and sides that protect the machinery from the weather, supports runways on which are placed traveling cranes for handling the heavy machinery.

The building is 40 ft. in width and 210 ft. in length. Its general appearance and the arrangement of the machinery in it are made clear by the accompanying drawings and photographs. A railway track runs through

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the building on the upper level. The loaded trains from the quarry enter on this track and as each car comes opposite the hopper over the big jaw crusher its load of broken stone is dumped into the hopper. After dumping, the empty cars go on out of the building and are switched back on a return track to the quarry.

The crusher which first receives the broken stone is a Buchanan jaw crusher having an opening 48 in. wide and 72 in. long. The opening through the jaws of this crusher is 10 in. in width; and as a large part of the rock from the quarry is broken up by the blasting into pieces smaller than this, the rock passes through this crusher very rapidly. From the bottom of this crusher the rock falls by gravity into the hopper of a No. 10 gyratory crusher, which reduces the rock to a maximum size of 5 in. By the time the rock leaves this crusher, a considerable proportion has already been crushed into market sizes, so the stream of broken rock is carried upward by an inclined belt conveyor to a scalping screen. The stones already broken to market size drop through the perforations in the screen and fall down a chute to a conveyor belt, which carries them to the main conveyor belt to the storage bins.

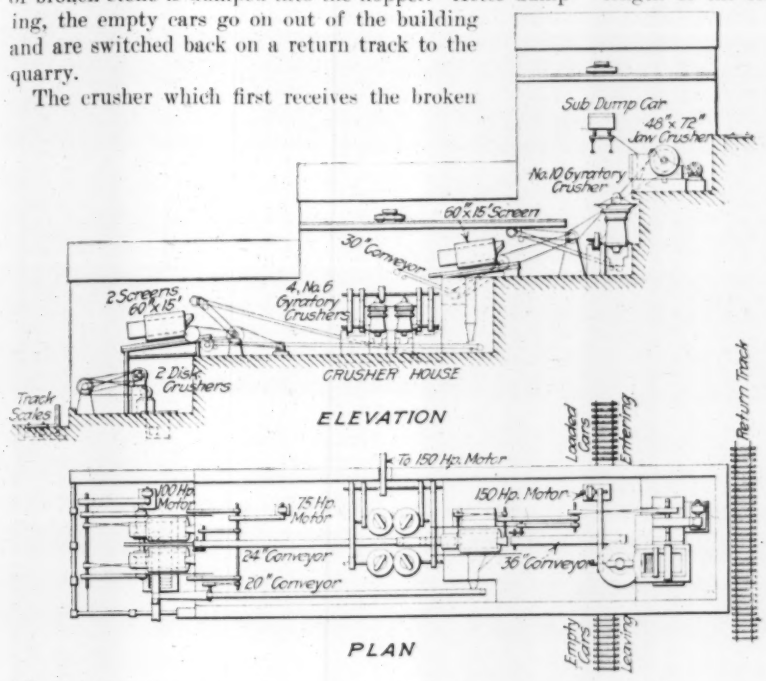


FIG. 2. PLAN AND LONGITUDINAL SECTION OF CRUSHING PLANT

The stone which requires further crushing passes the length of the scalping screen and is delivered by a belt conveyor to a battery of four No. 6 gyratory crushers. These reduce nearly all the stone, none of which, it will be remembered, is over 5 in., to market sizes. The stone discharged from this battery of crushers is carried by a belt conveyor to a pair of scalping screens placed in parallel. Any tailings passing these screens fall into a pair of disk crushers, which may be adjusted to break the stone as finely as may be desired.

The three streams of broken stone—that from the first scalping screen, that passing the screens beyond the four No. 6 crushers and that leaving the disk crushers—are all delivered to the foot of a conveyor belt leading from the lower end of the crushing house to the top of the screening and shipping-bin house, shown in Fig. 3. This is a huge rectangular wooden bin, 100 ft. long, 35 ft. wide and 30 ft. high, divided into six compartments, each containing a special size of stone.

Over these bins are two pairs of revolving screens, the first pair of which receives all the stone brought up from the crushing house by the conveyor belt. These screens take out all the 2-in. stone and 1¼-in. stone and drop it into the first two bins, discharging all the finer stone upon a conveyor belt, which delivers it to the second pair of screens.

The jackets of these screens have ⅜-in. holes for the first half of their length and ⅝-in. holes along the second half. All stone passing through the ⅜-in. holes falls upon a pair of pulsating screens, one located under each revolving screen. These clean the stone and separate the dust and dirt from the ¼-in. stone. The ⅝-in. holes in the screen jackets remove the ½-in. stone, and the tailings from the screen give 1-in. stone while from the jacket comes ¾-in. stone.

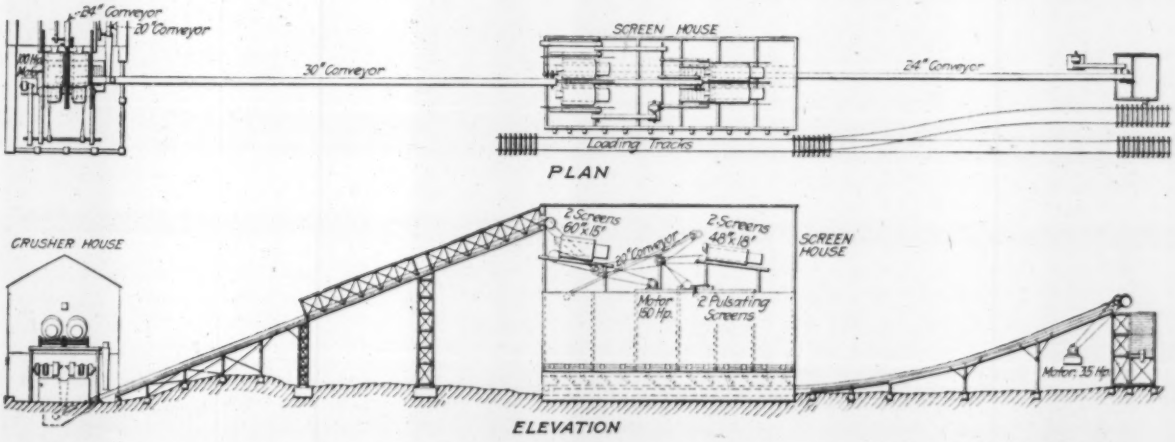


FIG. 3. PLAN AND LONGITUDINAL SECTION OF BELT CONVEYOR AND SCREENING AND SHIPPING-BIN HOUSE

The seven revolving screens are manganese steel throughout. The first five are made from the same pattern, the only difference being in the size of the holes in the screen plates. Each screen is equipped with a dust jacket in which the holes are smaller than those in the main screen. This greatly increases the capacity and efficiency of the screens.

On account of the continual forward movement of the crushed stone through the crushers and screens, the output is greatly increased, as no tailings are brought back to the crusher. The opening in the crushers can be adjusted so that if one crusher becomes overloaded and flooded with stone its opening can be increased or the opening of the crusher back of it may be reduced. This gives maximum capacity for all crushers.

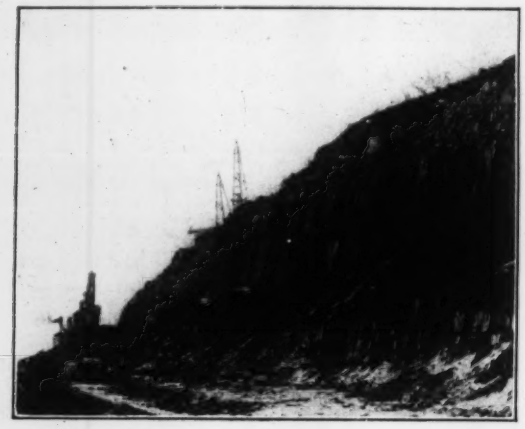


FIG. 4. TYPICAL VIEW OF QUARRY FACE

Should the initial crusher be out of commission, the stone can be fed direct from the quarry cars to the No. 10 crusher. Should the No. 10 be out of commission the stone can pass from the jaw crusher direct to the four No. 6 crushers. The screens can be operated singly or in pairs as production requires, and any screen may be stopped for repairs without stopping the whole plant. It would require a series of accidents to put the entire plant out of commission, as any crusher can be bypassed.

Especial attention has been given to standardization throughout the plant and as few different sizes are used as possible. This reduces the stock of spare parts to be carried and the chance of errors in making repairs.

Care has been taken to avoid wear where the stream of stone enters and leaves the belt conveyors, the endeavor being to make stone fall on stone rather than on steel chutes. All skirt-boards are free from contact with the belts and are held by braces fastened to the stringers below the conveyors.

An interesting feature in the design is that when necessary the entire plant of eight crushers can be duplicated within the present building without moving a single crusher from its present location.

The entire crushing and screening plant is driven by seven electric motors, one of 250 hp., three of 150 hp. and one each of 100, 75 and 35 hp. The 250-hp. motor drives the big jaw crusher, which requires about 200 hp. under normal conditions, but in cold weather and when starting under a load it sometimes calls for considerably more. The 250-hp. motor therefore drives also the first scalping screen and two belt conveyors which run empty until the jaw crusher has begun running and started the stream of stone.

On account of the limited room between the jaw crusher and the rock wall at the upper end of the power house, the motor was placed close to the crusher, the shaft centers being only 10 ft. apart. A "Lenix" drive has been installed on the belt by which the motor drives the jaw crusher. This drive is essentially a counterweighted idler which rests on the slack side of the belt and greatly increases the arc of contact on both pulleys.

The electric current to operate the plant is transmitted at 6600 volts over a private pole line seven miles from the powerhouse of the New Haven Electric Co. This three-phase current is delivered to a bank of outdoor transformers which deliver current at 550 volts to the main switchboard, located in a small building entirely outside the crusher house. All of the motors are of the slip-ring type, with outside dust-proof collector rings, and all motors of 100 hp. or over have three bearings.

To furnish water for the works, a pumping plant was erected at a small lake about a mile distant. Part of the 6600-volt current is stepped down to 2200 volts by a small transformer at the crusher house, and is transmitted thence to the pumping station, where it is further stepped down to 220 volts for running the pump motor.

Returning now to the screen house, the six rectangular bins in this house have a combined capacity of 3000 cu.yd. The stone from these bins can be delivered either directly into railroad cars run alongside the bins or the bins can be emptied from the bottom upon a belt conveyor running through a tunnel underneath the center of the screen house. This belt conveyor delivers the stone into a small shipping bin, from which it may be chuted directly into a railway car, as will be evident by the plan view. Of course the stone is as a rule drawn from the chutes in the side of the bin. When, however, there is a particular demand for one size of stone it may be necessary to draw the bin down below the level of the side chutes, and under these conditions the bottom chutes and the belt conveyor are used.

FIG. 5. MASS OF ROCK BROKEN UP BY BLAST

A yard, with capacity for 40 standard-gage railway cars, is located just east of the screen house. The empty cars run by gravity down to the screen house, where they

are loaded, and then pass over track scales at the end of the crusher house, and thence to a loaded car yard of 40 cars' capacity. Here the loaded cars are made up into trains for hauling to tidewater, six miles distant. The line is direct and the grade is easy in the direction of the traffic.

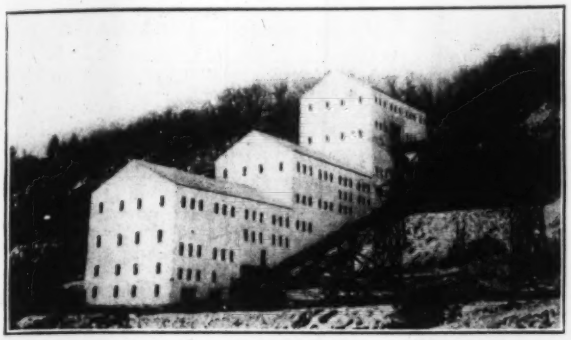


FIG. 6. VIEW OF CRUSHER HOUSE

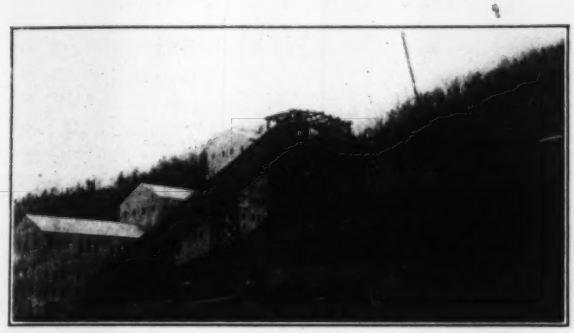


FIG. 7. SHIPPING BIN AND SCREEN HOUSE UNDER CONSTRUCTION

FIG. 8. GROUP OF FOUR NO. 10 CRUSHERS WITH JAW CRUSHER ABOVE IN BACKGROUND

At the tidewater terminal, which is about 70 miles distant from New York, the cars may be dumped into storage bins of about 4000 cu.yd. capacity or they may be dumped from a high trestle on a ground-storage area where an unlimited amount of stone can be stored. For shipping stone by water the scows are loaded by belt conveyors from the storage bins. A basin has been dredged sufficiently large to hold the scows and channel extending from the basin out to deep water, a distance of about 1000 ft. Direct connection is also made at this terminal with the tracks of the New York, New Haven & Hartford R.R. and of the Connecticut Co.'s electric line, while the Shore Line electric railway intersects the company's railway near the quarry.

The entire work of construction and equipping the quarry was placed by the New Haven Trap Rock Co. in charge of C. W. Blakeslee & Sons, contractors, of New Haven, and the work has been done by this organization under the writer's direction by day labor. In connection with the construction and erection, credit is due to Mr. Clarence Blakeslee, of the New Haven Trap Rock Co., and to Sheldon S. Yates, Principal Assistant Engineer.

Failure of Infiltration Wells

Another addition to the long list of infiltration cribs, galleries and wells in or near rivers which have failed sooner or later comes from Madison, Ind. In the course of a paper reviewing the history of the water-supply of Madison, beginning in 1870, read before the Indiana Sanitary and Water Supply Association in February, 1915, J. W. Moore, of Indianapolis, stated:

In 1909 and 1910 the city installed 12 infiltration wells in the bed of the river, at a cost of $38,000, connecting them to the suction pipe. These wells were made of cast-iron cylinders, each 4 ft. in diameter and 6 ft. in length, the upper end in each case being closed. These cylinders were sunk in the bed of the river until the top of the cylinders were on a level with the sand and gravel, a 12-in. suction pipe entering near the top and extending to within 20 in. of the lower end of the cylinder or bottom of the well. At the time of installation the cylinders were kept free of sand and gravel.

After the suction line had been connected to each well, the valves admitting water direct from the river were closed and the water was forced to come up through the area covered by the open end of those 12 cylinders, they having a combined area of 151 sq.ft.

The result was that sand was carried through the pumps with the water in such quantities that the sand surrounding the cylinders caved in and direct connection with the river was established.

The entire failure of these infiltration wells was established by tests made in June, 1914, by Mr. Diggs, Water Chemist, Indiana State Board of Health.

It is now proposed to sink wells in the water-bearing gravel along the River bank for the future supply.

The Reappearance of Sailing Ships in Ocean Traffic, due to the prevailing scarcity of vessels and high rates, gives interest to an announcement concerning the use of the Panama Canal by sailing vessels. Twenty years ago when the relative advantages of the Panama and Nicaragua canal routes were a matter of sharp controversy, a stock argument against the Panama route was its disadvantage for sailing vessels on account of the calms which prevail on the Pacific side. Notwithstanding these calms the "Canal Record" states that sailing vessels will find great advantage in using the canal compared with the trip around Cape Horn. Including the chance of possible delays by calms, it is estimated that the average time of transit of a sailing vessel from New York to San Francisco may be reckoned at 60 days, including one day in the canal, through which it would be hauled by a canal tug. The return trip should consume 57 days in the winter months and 62 in the summer season. The average time for sailing vessels from New York to San Francisco around Cape Horn is 140 days, and the return voyage requires 110 to 115 days. It is estimated that the cost per day for operating a vessel of 2000 tons net at sea is $75 and that the $2700. At this rate, if the canal passage saves 36 days in toll on such a vessel for canal passage would approximate the length of the voyage, it would be sufficient to pay the canal tolls, whereas on the average voyage from New York to San Francisco, the canal would save 80 days in time.

Field and Office

Pile Penetration With and Without Water Jet

By F. Y. Parker*

Extensive observations of the behavior of wood piles driven in dike construction along the Mississippi River between the Ohio and Missouri Rivers were made during the spring and summer of 1914.

The dikes consisted of three rows of three-pile clumps, 9 ft. apart, the clump piles being driven at the apexes of approximately equilateral triangles the sides of which were between 3½ and 4 ft. long.

The soil was for the most part sand and quicksand, although a certain amount of mud and some gravel were encountered.

Hammers and Jet-Pumps

Single-acting steam hammers and ordinary drop-hammers raised by hoisting-engines with friction clutches were used on the work. The drop-hammers weighed 2400 lb. each; they were used with 400-lb. Casgrain pilecaps. The total weight of each steam hammer was 7000 lb., of which the ram constituted 5000 lb. These hammers could deliver a maximum of 60 blows per minute; but unless the piles were fairly large and straight the maximum could not be reached without danger of breaking the pile. The rate of delivery was between 45 and 50 blows per minute for all crooked and small timber, which allowed the pile to recover between blows.

In order that the drop-hammers could be interchanged with the steam hammers, all leads were dimensioned alike except in height. A spare drop-hammer and pilecap were kept on hand.

As the steam-hammer footblocks had larger recesses than the drop-hammer pilecaps, the latter (fitted with cushion-blocks adapted to the footblocks) were inserted in the steam-hammer leads whenever it was desired to drive the piles butt down. When this insertion was not made, much energy was dissipated, and the pile broomed and not infrequently broke.

The drop-hammer drivers were equipped with Hooker 12x6¼x16-in. jet-pumps running between 50 and 60 r.p.m.; the jet-pumps on the steam-hammer drivers were 10x6x10-in. Gordon duplex.

Under 100 lb. of steam and water each Gordon pump made 84 r.p.m., discharging (through 50 ft. of 2½-in. iron pipe and 50 ft. of rubber hose) 420 gal. of water at 65 lb. per sq.in. from a 1¼-in. nozzle. With the nozzle submerged, the impact† at various distances therefrom was as follows: 120 lb. at 1 ft., 115 lb. at 2 ft., 100 lb. at 3 ft., 50 lb. at 4 ft. However, for jetting purposes both the Hooker and the Gordon pumps approximated 60 lb. nozzle pressure (under water) 100 ft. from the pumps.

Method of Jetting

Each jet-pump was connected to a stationary 2½-in. gas pipe, extending from the pump to the second platform, in the piledriver leads. A hose connected this pipe to coupled sections of 2½-in. gas pipe with the end section reduced to a 1¼-in. nozzle.

Before placing the jet-pipe the pile was driven several feet into the ground; driving was then stopped and the pipe placed against the pile and carefully lowered to the river bottom. The pump was then started and the pipe churned below the foot of the pile. A rope leading from the pipe through a snatchblock to the spool of the hoisting engine was used for this work. As soon as the jet became effective, driving was resumed, and the jet kept a few feet in advance of the pile until the desired penetration was secured.

Indentation of Piles in a Group Driven without Water Jet

(Deepest indentation is in pile last driven, showing compacting of soil by driving)

When no further penetration was attained the jet-pipe was withdrawn and relocated against the pile. Occasionally several relocations failed to give results. Often a pipe "froze" in the ground and difficulty was experienced in withdrawing it; this was overcome by keeping the pipe-to-spool line taut, and tapping the pipe with a hammer or sledge.

Difficulty was always encountered in forcing the jet-pipe through the brush foundation-mattress of the dikes,

*U. S. Assistant Engineer, 428 Custom House, St. Louis, Mo.

†Impact was measured by means of a baffle-plate suspended under the jet-hose, and a spring-scale

which had been made and sunk in place before piledriving started.

After starting the jet the pile would sometimes drop several feet under its own weight plus that of the hammer, and this drop was followed by a marked increase in penetration per blow. This usually immediately followed each relocation of the jet.

Hammer Lines

Until last year, hammer lines of three-strand manila bolt rope were used; but comparative tests with four-strand lines proved that the latter had greater flexibility and longer life. These lines were attached directly to the drop-hammers (clutches were not used); although the hammer velocity is slightly reduced thereby, this reduction is more than compensated for by the greater ease and rapidity of hammer manipulation.

Steel cables were used for raising the steam hammers. When tried on gravity hammers (also without clutch) they were not as satisfactory as rope, on account of the greater stiffness of the cables.

Butts versus Tips Down

Neither shoes nor rings were used on the piles, but various experimental pointings were given to butts and tips.

The controlling factor in "butts or tips down" was to have, after driving, the greatest pile cross-section at the point of maximum bending moment. The desired penetration (about 20 ft.) was a constant; but the depth of water and the coning of the piles were unknown. Soundings gave the depth at pile clump locations; pile conings were estimated. From these data was estimated the greatest cross-section. In very deep or very shallow water it was only necessary to estimate the pile conings.

Deductions

A number of tables were compiled giving pile lengths, penetrations and drop of hammer for each blow, diameters of piles and dimensions of sharpened points. From these records certain facts were deduced:

1. Compacting of the soil occurred at pile clumps when the water jet was not in use. The accompanying view shows the effect. The piles of this green-cypress clump were driven by a steam hammer without jetting, to the same penetration. The imprint of the ram on the pile heads shows which pile was driven first and which last.

2. Both hard and soft woods were used for pile timber. When driven in connection with the jet no appreciable difference was noticed in their resistance to brooming and splitting. The kind of timber, whether green or dry, crooked, bowed or straight, bark on or off, butt or tip down, tip sharpened or square, seemed to influence "driving time" very little provided the jet was kept in proper position. Some crooked piles took longer to drive due to inability to follow pile movements with the jet.

3. Apparently the most important requisites for rapid driving were to keep the jet on line with, and a few feet in advance of, the sinking pile and to maintain the pile plumb in the piledriver leads.

4. The records indicate that chisel pointings, especially for tips, are preferable to square ends or pencil points. When the jet was not in use, the tendency of the piles to cant was less with the unpointed square-ended piles.

5. That great differences exist in the penetrability of sands was evident; the most pronounced irregularities appear in quicksands. A mixture of sand and gravel was easier to penetrate than either sand or gravel alone.

6. The superiority of steam over drop-hammers is unquestioned.

7. Instances occurred where the performance of the jet was disappointing; but the water jet is an invaluable adjunct of the hammer and a necessary part of every up-to-date piledriver equipment.

For driving average timber in ordinary soils, the writer advocates a medium-weight double-acting steam hammer striking 180 or more blows per minute in conjunction with a single-pipe water jet. The jet-pump should furnish, at a distance of 100 ft., 175 lb. pressure at a 1¼-in. nozzle submerged 10 ft. With this nozzle pressure the hammer would be merely an adjunct of the jet, and its use limited to a few blows at the beginning and end of each operation. Moreover the time required to sink a pile would be reduced to a minimum.

Heating Hub Bolts for Shrinking Large Flywheels Together

By H. B. McDermid*

In the field erection of large rotating parts of power machinery, it is common to shrink the parts together with large bolts. The unusual method employed on a recent large job for securing safe results should be of interest.

The shafts for some 15 very heavy rotors for revolving-field vertical-shaft electric generators were each set standing on a large integral coupling flange. The half rotors were placed in position, being supported at proper height by concrete pillars. Cold hub bolts (usually four of the 12) were placed and set up tight, and the shrink-links for the rim joints were heated in an open fire and put in place.

The shrink-links were ready and supposedly were designed so that in cooling to room temperature the stresses would not be excessive. But how to use the hub bolts was a problem. They were 4 ft. long and the machines had to be tested for runaway speed, so that perfect control was necessary to prevent undue stresses. The experience was remembered of one inexperienced erector who heated his hub bolts to a dull cherry red, placed them and drew them up snug. An old-timer got him to sit down nearby in conversation and soon "Bang!" went the first bolt. In a few minutes the others went similarly.

A steel tank, large enough to hold eight bolts and much excess water, was secured and the bolts were boiled until it was certain that a uniform temperature had been secured—about 4 hr. Then each bolt was taken out, by special tongs on the crane hook, slipped into position and set up with a 4-ft. wrench and a 16-lb. sledge. After the eight hot ones were placed, the four cold ones were taken out and treated similarly, thus completing the job.

The total change of temperature was some 152° and, with a coefficient of expansion of 0.00000636, gave a total expansion of 0.00097 in. per inch of length. For a modulus of elasticity of 30,000,000 lb. the unit stress (equal to $E\,a\,t$, where E is the modulus of elasticity, a is the coefficient of expansion, t is the temperature change) figured to nearly 30,000 lb. per sq.in. If the material was a low-carbon open-hearth steel, with a commonly accepted elastic limit of 32,000-35,000 lb. per sq.in., then the bolts in question were given about all they should carry.

*1537 Cambridge St., Cambridge, Mass.

Jacking Up a Concrete Arch Over a Settling Pier

By W. P. Darwin*

For the past six years one pier of the Broad St. concrete viaduct at Jacksonville, Fla., has been separated by a continuous horizontal opening in which a number of screw jacks maintain the arches at their original elevation, while the base of the pier is settling at a gradually reducing rate. While a complete history of this novel condition does not now seem to be available, the writer has been able to prepare, from various conflicting sources, the following description of the bridge and the precautions taken to prevent its collapse.

The Broad St. viaduct is a series of concrete arches, reinforced according to the Melan and Thacher systems, carrying Broad St. across the railway yards. It is about 800 ft. long, with a 40-ft. roadway carrying two electric-railway tracks and two 10-ft. sidewalks cantilevered about 4 ft. beyond the parapet walls, the outer faces of arch rings being 52 ft. apart. The piers are of solid concrete 7 ft. wide and 52 ft. long, each being supported by 126 timber piles 40 ft. long (Fig. 2). The dead-load per pile is approximately 12 tons.

The pier which settled was erected in a location which was evidently the original bed of the present small body of water known as McCoy's Creek, a tidal arm of the St. Johns River. Old drawings indicate that several years ago a bay extended from the nearby river; this may have been of considerable depth at some former period. The river depth now, near this location, is about 90 ft. The piles supporting the piers were supposedly driven to rock and it is reported that after the pier had settled pipes were jetted to rock about 40 ft. below the surface adjacent to the pier.

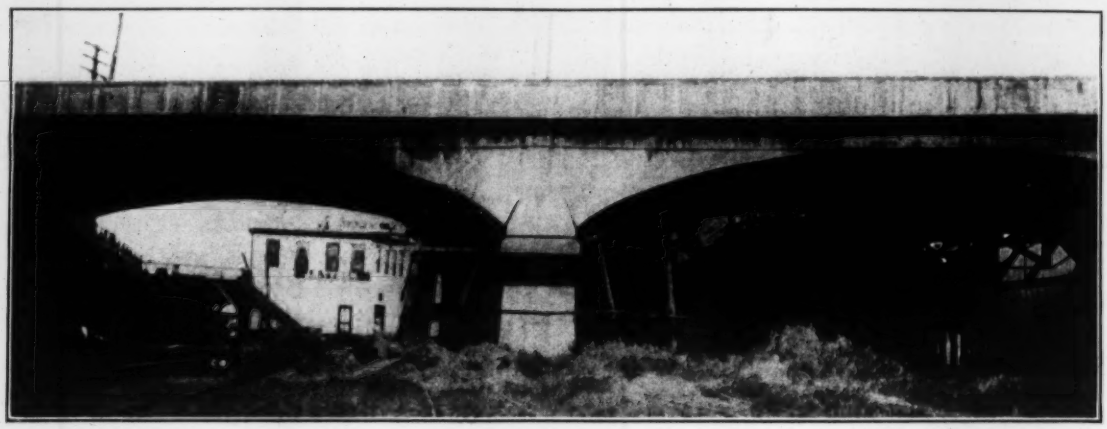


Fig. 1. Portion of Broad St. Viaduct, Jacksonville, Fla., Showing Jacks over Pier

*Engineer of Bridges, City of Jacksonville, Fla.

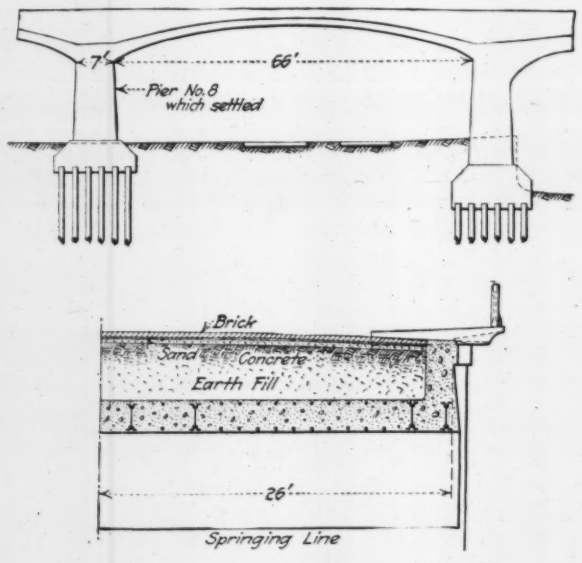


Fig. 2. General Details of Arch

It may be possible that the rock so encountered was a thin stratum of coral formation peculiar to Florida, and the piles pierced a shelving portion or a thin stratum which overlay a mucky material, under which may exist a more substantial material. The subsoil conditions in this section are somewhat peculiar, and tests should be employed in all important work. A story is related that a local piledriving man, working in the vicinity of this viaduct some years previous, struck a 45-ft. pile with a follower and the hammer disappeared in the ground not to be found again.

The pier which settled was constructed the full width of 52 ft., but the arches and half of the roadway were built at different periods. After one-half the structure had been completed several months it was noticed that the pier had settled a considerable amount, observation with instruments showing this to be about 9 in. While this movement had doubtless been taking place since the early stages of the construction, it was quite gradual and no one had noticed the movement until the pier had settled this distance. Then some worthy son of Martha proposed to "cut the thing in two and jack her up."

Timbers were immediately placed as shores on each side of the pier to the under side of the arch rings, as indicated by the inclined struts shown in the views herewith. These were borne on a timber grillage and a series of jacks which were tightened at intervals for several days, and, in the meantime, 150 holes were drilled about 1 in. in diameter and 8 in. deep entirely around the pier just below the springing line of the arches. Iron wedges were inserted in these holes and were successively struck with a light hammer for a period of some hours, when the pier

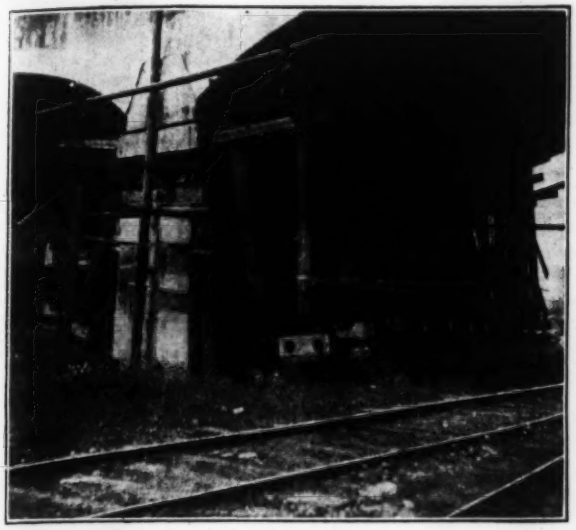


FIG. 3. NEAR VIEW OF JACKED PIER

broke in two, forming a horizontal crack. Afterwards some 500,000 lb. of iron was placed around the pier base on the projecting footing to hasten the pier settlement. When this was sufficient for the insertion of 9-in. jacks, these were placed around the perimeter of the opening and were kept tightened as the pier continued to settle. The total number of jacks employed is about 220; 110 being under the pier and 110 under the shoring.

The movement from that time is illustrated by the deflection diagram (Fig. 4) the total being about 3 ft. The diagram represents about the average settlement which has taken place. This has not been perfectly uniform, as

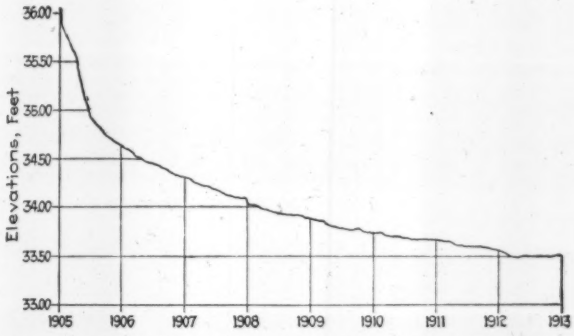


FIG. 4. DIAGRAM SHOWING SETTLEMENT OF BROAD ST. VIADUCT PIER

the end of the pier on the river side has settled about 7 in. more than the normal. The diagram does not indicate the movement for the past two years; it has, however, continued as heretofore, but is not so appreciable.

As the jacks both under the pier and under the shoring have been kept tightened no positive conclusion can be made as to just what is now supporting the pier. It may be either the grillage or the pier by simple soil bearing, or it may be that the piles have come to a firmer bed. Again it may be found that only a few of the piles are resting on an inclined stratum and are carrying the load under very excessive stresses.

Some measure for making permanent repairs to the piers will be undertaken before a great time. A convenient and satisfactory means for so doing might consist of a reinforced-concrete mattress construction entirely around the base of the pier for the obtaining of increased soil bearing area. A buttress arrangement for distribution of pressures could run up the sides of the pier. Such construction would considerably relieve the piles of their present loading and then when no movement could be detected in the combined footing the present opening could be filled with concrete. However, the adoption of this or other methods for strengthening the pier would be unwise until a careful examination of the subsurface conditions were made to furnish sufficient data for a basis of rational design. It is intended to make such examination at an early date.

It is of interest to note that no large cracks have developed in the viaduct although it has been subjected to such severe conditions. Certain cracks had developed at the arch haunches when the settlement was first discovered, but these were closed by the operation of raising the arches.

Floating a Clubhouse to a New Site

The clubhouse of the Cleveland (Ohio) Yacht Club was recently moved on scows some 8 mi. from the foot of East 9th St. to an island in Rocky River. The clubhouse is 3½ stories, frame with slate roof, 52x78 ft. in plan, and is estimated to weigh 270 tons.

Two plans to load the building on the scows were considered. The first was to drive piling from the shore out into the forebay to water deep enough to float the scows when loaded. The piling would then be capped and the building rolled out onto the scows. The second plan, which was adopted, was to dredge deep enough to permit the scows to be brought to a position where the building could be rolled along timber runways directly on board (Fig. 1).

Three scows carefully lashed together were used, a large one (40x120 ft.) in the middle and two smaller ones (20x75 ft.). The middle scow carried about 80% of the load. The load on the side scows was carried on timbers placed lengthwise and near the center, to permit rolling of the scows without transmitting the full effect to the building.

A horse turning a capstan on the land across the little bay to the left in Fig. 2 pulled the building aboard by a

FIG. 1. TIMBER RUNWAYS TO SCOWS

FIG. 2. CLUBHOUSE BLOCKED UP ON THREE SCOWS

16-part tackle between scows and building. The scows abutted against the shore piling.

The runway timbers were shored in their original inclined position, to prevent tipping of the scows as the load came on. Then they were raised to horizontal position. The building was moved forward again until it projected well beyond the ends of the runway timbers, over the scows, and timbers were put in place on the scows so as to bring the load well in from the ends of the scows, with consequently very little tipping. The total load on the scows was about 310 tons. It took 6 hr. to get the building on the scows. Two tugs towed the load to the new site in about 2 hr.

The work was done by local concerns at a total cost of about $5000, of which approximately $2000 was for dredging, rental of scows and towing service. The entire work of reconstructing the yachting station was under the direction of Izant & Frink, architects and engineers. Moving was done by G. Alexander & Son, in conjunction with the American Construction Co., which furnished the scows and tugs.

Waste of Metal in Mill-Building Columns

BY C. L. CHRISTENSEN*

Mill-building columns designed for wind pressure on the usual assumption of equal reactions at the bases of the two columns are unnecessarily heavy. The assumption is justified only for mill buildings with open sides. When the sides are closed the wind pressure on the windward side, acting directly to bend the windward column, changes the distribution of the reactions quite materially.

It will be shown below that the greatest column moment to be used in designing is equal to $\frac{5}{16}$ the product of wind pressure by height of column from base to kneebrace. This is only $\frac{5}{8}$ the wind moment as found from equal reactions.

SIMPLEST CASE—If the girder or truss carried by the columns is very stiff compared with the columns, and may be considered as completely rigid, then, for the conditions sketched in Fig. 1, the reactions x and y will be respectively $\frac{11}{16}$ and $\frac{5}{16}$ of the total wind. The maximum moment occurs at the top of the leeward column, the value of this moment being $\frac{5}{16}\,Ph$. The bending moment at the top of the windward column is only $\frac{3}{16}\,Ph$, in spite of the larger base reaction; the greatest moment in this column occurs $\frac{11}{16}\,h$ above the base, and is 0.236 Ph. On the assumption of equal reactions the column moment would be $\frac{1}{2}\,Ph$; the actual maximum moment is only $\frac{5}{8}$ this amount.

The above result was computed by considering only wind on the section AB of the column—i.e., below the base of the girder or kneebrace. Including the effect of wind on the section BB', and making the influence of this added wind as large as reasonably possible in a flat-roof building by taking $BB' = \frac{1}{2}\,AB$, the above proportion of $\frac{5}{8}$ increases to $\frac{3}{4}$. As an extreme condition, assume also a high roof, with peak B' so high that $BB' = AB$; then the moment on the leeward column, for wind on the whole height of the building, is only $\frac{13}{16}$ of the moment obtained by assuming equal reactions.

HINGED KNEEBRACES—Assuming that instead of a perfectly rigid connection along BB' we have a kneebrace hinged to the column at B, and the column section BB' free to bend, the calculation is slightly changed. For this case, assuming the depth of kneebrace to be $\frac{1}{4}\,h$, the reaction coefficients are respectively 0.7 (windward) and 0.3 (leeward) of the total wind pressure, the latter figure being less than the $\frac{5}{16}$ previously found.

The leeward reaction coefficient varies from 0.3 to 0.292 as the kneebrace depth changes from $\frac{1}{4}$ to $\frac{1}{2}$ the height h; all these values are lower than the $\frac{5}{16}$ previously found.

FLEXIBLE GIRDER—To find the effect of the flexibility of the truss or girder (Fig. 2) upon the column reaction, the case was analyzed where the truss has parallel chords and constant section. The conditions taken were: stiffness of truss $\left(\frac{I'}{l}\right)$ varying from 2 to 1 times the stiffness of column $\left(\frac{I}{h}\right)$; kneebraced depth varying from $\frac{1}{4}\,h$ to $\frac{1}{2}\,h$. In this range the leeward reaction coefficient ranges from 0.272 to 0.284. Thus, the flexibility of the truss decreases the leeward reaction below $\frac{5}{16}\,Ph$.

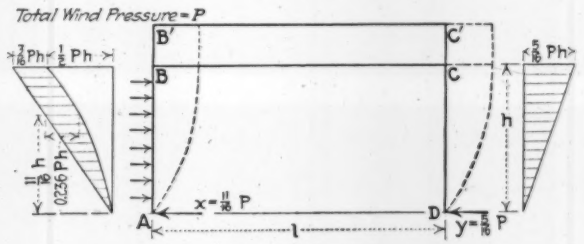


FIG. 1.

CRANE-GIRDER COLUMNS—In a crane-girder column the moment of inertia is much less above the crane-girder

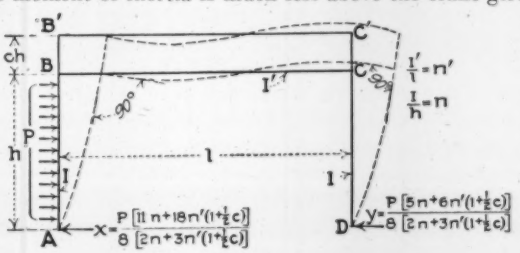


FIG. 2.

*2122 Alpine Place, Cincinnati, Ohio.

than below. Taking this factor into account, it is found that with upper portion of column one-third the total height, and the ratio of moments of inertia ranging from ½ to ⅓, the leeward reaction coefficient ranges from 0.297 to 0.301—i.e., it is less than with columns of constant section.

It may safely be concluded from the preceding figures that the columns of a mill building should generally be designed for a moment only ⅝ as large as that determined from the assumption of equal reactions; this is for wind below kneebrace. Including the wind on parts above the kneebrace a larger ratio should be taken; a safe allowance is 0.4 *Ph*, or 0.8 the moment resulting from equal reactions.

Two Types of Joint between Walls and Bottom of a Reservoir

The following notes describe (1) the joint between a concrete wall built on an old reservoir embankment and the slope paving; and (2) the joint between the walls and bottom of a new concrete reservoir. These notes are received from Morris Knowles, Consulting Engineer, Pittsburgh, Penn., who was engineer for both reservoirs.

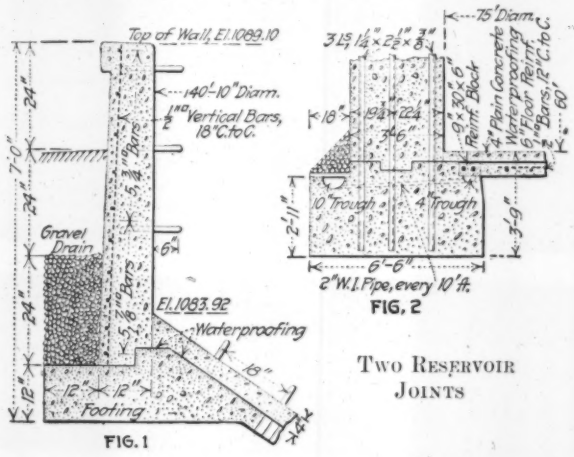


FIG. 1 FIG. 2

TWO RESERVOIR JOINTS

IRWIN RESERVOIR, IRWIN, PENN.—A circular reservoir 141 ft. in diameter and 14 ft. deep, in cut and fill, built in 1889, was relined in 1914 and its depth and capacity increased by the addition of a vertical wall at the top of the embankment slopes.

The existing brick lining on the bottom and slopes was cleaned and then smoothed up by cement plaster. This was covered by a continuous layer of asphalt, $\frac{3}{16}$ in. thick, reinforced by burlap, and this in turn was protected by a 5-in. layer of concrete. A circular wall (Fig. 1) was built at the top of the slope and reinforced for full water pressure. It was of 1:2:4 concrete, having river gravel and sand for aggregate and was all cast at one time, requiring 19 hours. A broken-stone drain to cut off seepage from the reservoir and prevent groundwater pressure on the floor, when the reservoir was empty, was constructed around two-thirds of the reservoir.

The whole work required 63 working days, but the reservoir was empty during only 25 days. The reservoir was put in service in August, 1914, and is tight and satisfactory.

CASTLE HILL RESERVOIR, TUSCALOOSA, ALA.—This is a circular reinforced-concrete reservoir, 75 ft. in diameter and 60 ft. high, having a capacity of 2,500,000 gal., and is now being constructed.

The foundations were excavated to 9 ft. below the original surface. The material obtained from this cut will be banked around the outside of the reservoir. The wall is of 1:1½:3 concrete, using bank and lake sand and gravel for the aggregate. It was designed with low stresses to make the concrete aid the steel. Enough steel has been provided to take the entire load at 12,000 lb. stress per sq.in. The lower layer of floor is reinforced with rods at right angles and is covered with a waterproof mat of asphalt $\frac{3}{16}$ in. thick, reinforced by burlap. This is protected by a 4-in. layer of concrete, laid in blocks.

The soil is a red clay. In order to prevent seepage from the joint between the vertical wall and floor reaching the clay and softening it, a drain to intercept the seepage has been provided around the inside of the foundation block and connected to a similar one on the outside of the block. Four inspection manholes have been provided.

A cross-section of the wall and floor at this joint is shown by Fig. 2.

New Sewer-Cleaning Machine

A hydraulically operated sewer-cleaning machine with revolving blades, somewhat similar to the one described in ENGINEERING NEWS of Dec. 19, 1912, has been used with success in Warren, Penn., Fort Wayne, Ind., Borough of Queens, New York City, and Bradford, Penn. It is the invention of W. J. Stevenson, a former employee of the Kansas City (Mo.) sewer department and was patented in July, 1914. Fig. 1 shows the machine, but without the side brackets which make it adjustable to any size of circular pipe sewer.

The motor for turning the blades is a 3½-in. hydraulic turbine operated through a standard fire-hose hydrant connection. The turbine is especially designed for low pressure services, so it operates through a train of gears which multiply the speed of the cutter blades to 3½ times (600 r.p.m.) the speed of the turbine. The cutter blades bend backward and are flexible enough to ride over

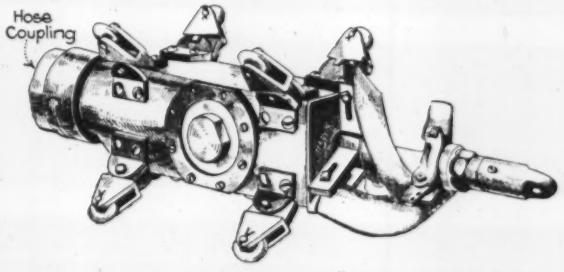


FIG. 1. STEVENSON TURBINE SEWER-CLEANING MACHINE

low joints and not catch on rough joints. These blades are made in different sizes to fit pipes from 6 to 30 in. in diameter.

The blades are so designed as to throw the water out not fully at right angles to the axis of the cutter, but with a considerable forward velocity (Fig. 2). The blades are further designed to act as a worm-screw conveyor in pushing the sand and silt forward, as well as to scrape the sides of the pipe. The adjustable traveling carriage

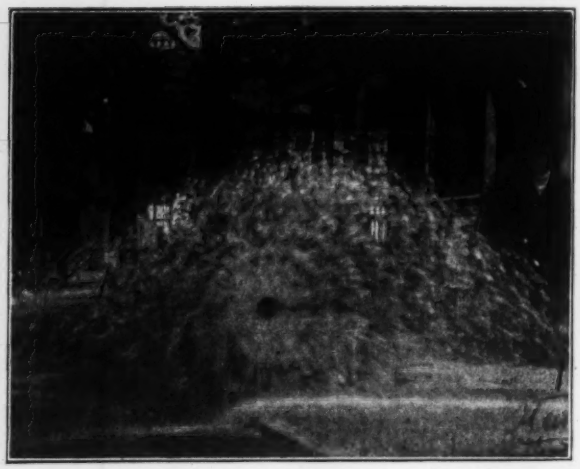


FIG. 2. WATER THROWN BY CUTTER BLADES OF SEWER-CLEANING MACHINE

is made of steel, but the machine proper is of bronze, the central shell being a single heavy casting. It is drawn through the sewer by a windlass and cable.

E. W. Firth, Bureau of Sewers, Borough of Queens, New York City, is authority for the statement that the machine successfully cleaned a 12-in. pipe sewer in Jamaica which had become practically plugged up; from this sewer several large masses of root fibers, with the main roots ½-in. thick, were cut through and removed. The machine is made by W. J. Stevenson, 1720 Cedar St., Milwaukee, Wis.

A Problem in Truss Design

The interesting little problem advanced by Prof. Edgar Marburg of the University of Pennsylvania in our issue of Mar. 11 is solved by C. H. Moorman, Augusta, Ga., as shown in Fig. 1. The sketch at the left shows the arrangement for compression in top chord at the wall, while the sketch at the right is the arrangement of web members for tension in bottom chord. This is an original system of webbing, different from that given by several other correspondents.

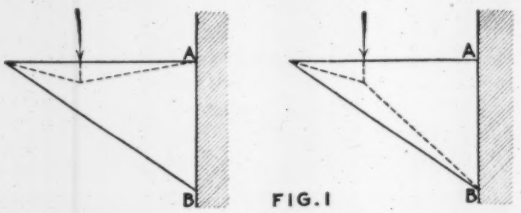


FIG. 1

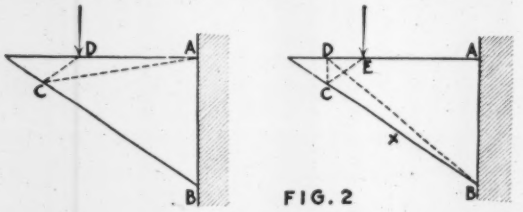


FIG. 2

Edward Godfrey, Pittsburgh, Penn., gives the solution reproduced in Fig. 2. The same solution is given by Chas. W. Chassaing, East St. Louis, Ill., with the modification that *EC* (see Fig. 2, right) is vertical and *CD* inclined; this, however, leaves the solution unchanged in principle. In one respect the solution is inferior to that of Mr. Moorman because the entire length of the cantilever is not used. The portion to the left of *CD* is idle or unnecessary material, whereas in Fig. 1 the spirit of the problem is better complied with because the entire cantilever is necessary to the truss action. J. C. Morris, New Orleans, La., gives the same solution as Fig. 2, except that in the left-hand sketch *DC* is vertical, which leaves *AD* without stress instead of in compression.

E. P. Culver, Union College, Schenectady, N. Y., gives the solution shown in Fig. 3. The one for compression in the top chord is seen to be identical with Mr. Godfrey's, while the one for tension in the bottom chord is identical with that given by Mr. Moorman. In the former case, as already noted, the point of the cantilever is idle.

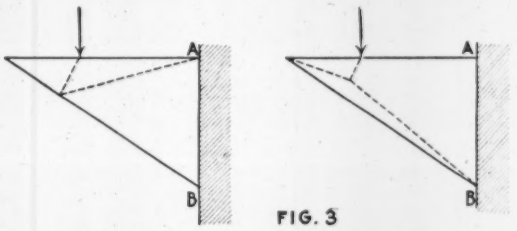


FIG. 3

S. Napp, Philadelphia, Penn., attempts to solve the problem by introducing a third support near mid-height of the wall leg of the cantilever and running a member to this support from a point on upper or lower chord. Under the conditions of the problem, this must be regarded as not permissible, since it changes the reactions.

Emergency Meals for Philadelphia Water-Works Employees—A commissary was added to the facilities of the bureau so that men suddenly called upon for all-night work can be furnished with hot coffee and food. This is not only a humane expedient, but good business policy as well, for men called unexpectedly from home, or required in an emergency to continue all night, following an ordinary day's work, cannot supply themselves with proper food. * * * During the severe snowstorm in March, when traffic on street-car and railroad lines was seriously interrupted, the operating forces at a number of the outlying pumping stations and filters were unable to leave the stations for many hours nor could the relief shifts get there. These men come to work provided with only one meal. Naturally when their shift was increased from 8 to 24 hr. the problem of securing food became urgent. To provide against such a situation in the future, arrangements have been made for placing certain standard food supplies at these outlying stations.—From 1914 report of C. E. Davis, Chief, Bureau of Water, Philadelphia.

Paper Tracings Treated with Carbon Paper as a Substitute for Ink Tracings—Lloyd T. Emory, Philadelphia, describes an interesting expedient he used some time ago in getting out a set of working plans in a hurry while on the road. The only drawing materials on hand were two triangles, a hard pencil and a scale. Getting some tough tissue paper from a dressmaking establishment, he first made the drawings in pencil on the tissue paper, then laid some sheets of carbon paper face up on the table with the tracings over them, and retraced all the lines of the drawing, thus backing them with the imprint of the carbon. Only 48 hr. was available for the set of plans; in 20 hr. straight work they were completed and time enough was left to get them printed in the blueprinting room of a local shop. He has since used the idea extensively.

The claim is made that with carbon tracing a paper drawing can be done in one-fourth or one-third the time of making an ink tracing; but not all draftsmen will agree on this point. In any event the method is applicable only to simple drawings—large-scale details and the like—and not to drawings with fine detail, topographic maps, etc.

When several drawings with the same foundation work but with alternative details are to be made, a modification of this method can be applied, using double-faced carbon paper and two or more sheets of paper.

Editorials

An Age-Long Complaint

But for my part, Cæsar, I have never been eager to make money by my art, but have gone on the principle that slender means and a good reputation are preferable to wealth and disrepute. For this reason, only a little celebrity has followed; but still, my hope is that, with the publication of these books, I shall become known even to posterity. And it is not to be wondered at that I am so generally unknown. Other architects go about and ask for opportunities to practice their profession; but I have been taught by my instructors that it is the proper thing to undertake a charge only after being asked, and not to ask for it; since a gentleman will blush with shame at petitioning for a thing that arouses suspicion. It is in fact those who grant favors that are courted, not those who receive them. What are we to think must be the suspicions of a man who is asked to allow his private means to be expended in order to please a petitioner? Must he not believe that the thing is to be done for the profit and advantage of that individual?

Substitute "engineer" for "architect" and modernize the language and the above quotation would be very acceptable as a contribution to one of the many current discussions on "The Status of the Engineer." The fact that it was addressed to Augustus Cæsar by one Vitruvius, a Roman architect-engineer, some nineteen hundred years ago, only shows how constant is human nature in spite of the progress that has revolutionized the materials and methods with which man works.

Can Sewage Sludge Be Made Valuable as a Fertilizer?

At a meeting of the Lake Michigan Water Commission, held at Milwaukee on Mar. 19, Dr. Edward Bartow, of the University of Illinois, described some remarkable experiments in sewage treatment now in progress in the University laboratory, using the process first tried at the Lawrence (Mass.) Experiment Station and subsequently developed by Dr. Gilbert Fowler, of Manchester, England, in which the sewage is aërated in tanks by forcing air through the liquid. The same process is being experimented with on a much larger scale by the city of Milwaukee at the Jones Island Sewage Experiment Station under direction of T. Chalkley Hatton, Chief Engineer of the Milwaukee Sewerage Commission; and the apparatus used was examined by those attending the meeting who visited the station.

Dr. Bartow exhibited samples of the dried sludge produced by the process in his laboratory that were practically inodorous. The most remarkable exhibit shown by Dr. Bartow, however, was a sample of sludge obtained from this process containing 6% of nitrogen in a form available for plant food; and it was stated that the sludge in this form had had its fertilizing value in nitrogen, phosphorus and potash compounds estimated at $15 to $20 per ton. The sludge in this form had, of course, a strong odor resembling that of ordinary commercial fertilizer. The Agricultural Experiment Station at the University of Illinois is carrying on experiments in the use of the sludge as a fertilizer in the growth of wheat, and Dr. Bartow exhibited photographs showing the marked effect of the sludge in stimulating plant growth.

It will be understood, of course, that these experiments of Dr. Bartow are made on a laboratory scale and the similar work being done by Dr. Fowler at Manchester is likewise small-scale work. At the Milwaukee sewage station, however, experiments are in progress on a large enough scale so that it is hoped definitely to determine whether the process is applicable to the treatment of Milwaukee sewage before its discharge into the lake.

In Milwaukee the question of possible values in the sludge produced is of less importance by far than the possibility of treating the sewage of the city in a comparatively small area of aërating tanks. Sprinkling filters large enough for the sewage of Milwaukee would require either the pumping of the sewage a very long distance or else the purchase of a large tract of land at a high price.

The commercial feasibility of the aëration process (which by the way is being experimented with at a number of places besides those mentioned) is yet to be demonstrated. The volume of air required, the feasibility of the process in cold climates and numerous other questions will have to be settled by experimentation on a large scale before the process could consistently be recommended for adoption. It is nevertheless of great interest that even on a laboratory scale it has been possible to produce a sewage sludge which, instead of being of little more value than so much inert mineral for application to land, has been demonstrated to possess high value as a fertilizer.

The Hydro-Electric Development at Cedars, Quebec

An interesting piece of engineering design and a noteworthy feat in construction are portrayed elsewhere in this issue in the description of the Cedars Rapids hydro-electric plant on the St. Lawrence River near Montreal. The capacity of the eventual plant, 160,000 hp., the present installation of machinery, 100,000 hp., and the dimensions of the various parts of the works all mark this as one of the largest electric generating stations on the continent; it probably is the largest headrace-canal plant to be found in America.

The general design of the works will be recognized as typifying the best engineering practice of the day, though to few will the main features seem particularly novel—separate generator and transformer houses, flaring elbowed draft tubes, molded concrete scroll cases, governors using water instead of oil, single top bearings carrying the whole turbine-runner weight and thrust, etc., have been used before. There is, however, a wealth of new detail, which no article can adequately present, necessary in adapting such desirable ideas to local conditions. For instance, the turbine-units are the largest known in dimensions and weight and therefore probably have the lowest speed for such capacities; the governor-water supply presents an interesting study; the service and safety features of the duct lines carrying generator feeders

are highly developed; reinforced-concrete unit insets have been used in the plant superstructures on a scale not before attempted; and the provision for protection against interruptions due to ice has been carried to an extreme probably not seen anywhere else.

One of the most interesting things on the construction side of the work at Cedars, particularly evident in these last few days during which the work has been finally closed down, is the spirit of coöperation and appreciation which has existed between the engineers for the power company and the general contractors. Instead of prospects of long drawn-out litigation and a general feeling of suspicion and hostility, there is a continued friendliness between both parties—partly evidenced by abundant expressions of mutual appreciation.

The job at Cedars was work of great magnitude, as is shown by the quantities involved, 1,800,000 cu.yd. of earth excavation, 650,000 cu.yd. of rock excavation, 103,000 cu.yd. of concrete, and the capacity of some of the equipment gathered together, five 40-ft. concrete mixers, seven 60- to 75-ton shovels, twenty-six locomotives, etc. The completion of this gigantic work in a little over two years is in itself a noteworthy feat.

There are many points in the notes on the contractors' plant, work and local conditions which will be of help to others. For instance, the inventory of the more important pieces of equipment and the outline of results secured with it constitute a transferable part of these contractors' experience. A half million dollars was saved on some ten million by avoiding the usual winter interruptions. The success in expediting construction and reducing cost by adopting, in the structures and assembly of machinery, factory-production rather than field-erection processes is a single illuminating feature capable of further development.

New Work by Engineers

The discussion of needed changes in the constitution of New York State which took place at the House of the American Society of Civil Engineers on the evening of Mar. 17 was an encouraging event for two reasons: (1) Because so large and distinguished a body of representatives of the great national engineering societies responded to the call from a committee of the American Society and met to discuss large questions of public policy; and (2) because of the spirit of both the discussions and the conclusions reached as to what constituted, to use a good old phrase, "the sense of the meeting."

Elsewhere in this issue we have outlined the conclusions reached and given some idea of the spirit shown at the meeting. With both the main conclusions and the spirit shown in reaching them we are in hearty accord.

As to the spirit of the discussion, the highest note struck, and one that met with general assent, was that the greatest benefit to the citizens of New York State, rather than the advancement of engineers individually or as a class, was the thing to be sought in formulating the consensus of opinion among engineers as to needed changes in those parts of the New York constitution which most directly concern engineering work and engineers.

The conclusions reached were notable alike for what they retained and for what they rejected of the suggestions laid before the meeting by Messrs. Tuttle, Hodge and Flinn, the chosen representatives of the American Society of Civil Engineers at the Constitutional Convention. Endorsement was given to all the suggestions except those designed to compel the Governor of New York to choose his engineering appointees from lists submitted to him by the governing body of the American Society of Civil Engineers. The other major suggestions of the committee were so well reasoned that we can only feel that this one was brought forward only as one bound to arise but which should be given an early and conclusive veto; a veto, too, which may serve as a warning whenever it is proposed that any one of the national engineering societies should be given sole and supreme power to nominate candidates for appointment to state engineering offices.

We hasten to add that the decision just noted is based upon principles of responsible administrative government which apply in no measure whatever to some other proposals for the selection of names to be chosen from in filling responsible engineering positions. No governor choosing what is virtually his cabinet should be limited to names submitted by any private society or societies, whether professional, commercial, civic, or religious; nor should any capable engineer be excluded from a state office because he is not a member of a certain engineering society—as would virtually be the case if the suggestion in question were embodied in a state constitution. If, however, a governor of a state or the President of the United States should ask an engineering society for a list of names to choose from in filling an office the case would be far different.

The meeting went as far as could reasonably be expected at the time in laying down the broad principle that certain state offices should be filled by engineers selected by the Governor of New York solely because of fitness for the position. The meeting also acted wisely in accepting a suggestion so worded as to leave the governor free to appoint other than an engineer for Commissioner of Public Works. To make the wisdom of this conclusion clearer, it should be added that the proposed Commissioner of Public Works would be a member of the Governor's political family, and would have under him Bureau Chief Engineers, so the Governor should be given a relatively free hand in selecting his Commissioner of Public Works, and should look first of all for a man of marked executive ability, rather than for one who was a member of any specific profession.

One other notable feature of the suggestions adopted was that all heads of executive departments should be appointed, instead of being elected by popular vote, as is now the case of the State Engineer and Surveyor and some other state officers. This accords with the short-ballot idea, which has swept over the whole country in the last few years.

Although the five general principles stated in advance of the specific suggestions offered by the committee included the civil service as a means for selecting and retaining heads of engineering departments and bureaus, the elimination of the provision for the nomination of candidates by the American Society of Civil Engineers left the matter of appointments to state engineering positions a little "up the air." The matter will be given further consideration by the committee—which would welcome written discussion on this and all other phases of the matters in its charge.

That the questions here involved are serious ones was strongly urged by many and generally agreed to; but

while the evils of changing state executive officers with every administration were admitted by all, no one seemed able to bring forward, on so short notice, any plan to avoid those evils which would probably be accepted by a constitutional convention or legislature, or which, even if so accepted, would be lived up to by the general run of governors and state officers.

For our part, many years of observation have convinced us that the only permanent relief will come from a more enlightened public opinion—lived up to—and that the best palliative meanwhile is an extension of the civil service, of the recent and more rational type, in which past experience and achievements are given due weight.

At the outset we stated that in the main the views adopted as the "sense of the meeting" met with our hearty approval. No arguments, or at least none that convinced us, were advanced at the meeting to prove that the work of the two present public-service commissions of New York State, with their ten members, could be satisfactorily performed by one commission of only three members—even though, as we agree ought to be done, the work of the commission should be confined to regulation, as soon as the New York City subway construction contracts are completed.

Another suggestion which seemed to be accepted with too little explanation of its real scope and need was the one designed to extend the powers of eminent domain which may be exercised by private corporations.

Before concluding, we venture to suggest that the five principles which, the committee stated, "it would seem desirable that the constitution when amended should insure," seem better adapted for insertion in a constitution than some of the ten specific suggestions made by the committee. Still, as modified and indorsed by the meeting, it may be that the essence of all the suggestions might fittingly go into a constitution. Just what is and what is not a fit requirement for a constitution is a subject on which much difference of opinion exists—a fact that the committee will doubtless consider with care before it goes to Albany.

Finally, whatever the outcome of this movement, it deserves commendation for its conception and for its execution thus far. We extend our best wishes for its success and trust that it will prove to be only the beginning of a series of notable efforts by engineers and engineering societies to do their proper and heretofore largely neglected part in the framing of constitutions and charters.

A New Departure in the Electrification of Steam Railways

Most of the work which has thus far been done in the substitution of electric for steam locomotives in railway service has been dictated by special conditions of operation, such as long tunnels, making the use of the electric locomotive advantageous to avoid the steam, gas and smoke produced by steam locomotives. The most prominent examples of such electrification work are on the three great railways entering New York City—the New York Central and the New York, New Haven & Hartford from the north through the long tunnel approach to the Grand Central Station, and the Pennsylvania coming in from the west through its tunnel under the Hudson River. Other notable examples are the pioneer electric locomotives for the Baltimore & Ohio tunnel in Baltimore, the electric operation of the tunnels under the St. Clair and Detroit Rivers, and of the Hoosac tunnel in western Massachusetts.

In other cases where steam railways have been electrified the traffic handled has been chiefly suburban or interurban passenger traffic and electric operation has enabled multiple-unit trains to take the place of locomotives with resulting advantages of frequent service of short trains. Typical examples are the Pennsylvania's West Jersey line from Philadelphia to Atlantic City and the lines of the Long Island Railroad.

For more than twenty years, electrical engineers have been urging that the electric locomotive should replace the steam locomotive on lines of general traffic. The experience on most of the electric operated lines, however, has been that the savings made in locomotive repairs and in fuel have not been sufficient to pay a satisfactory interest on the large investment necessary for the electric installation.

The gains from the adoption of electric traction have been generally due to its other advantages in connection with the handling of passenger traffic. On most steam railways, however, it is freight and not passengers which yields profitable earnings and it has been difficult to demonstrate that electricity could effect an economy in handling freight traffic.

The first two examples on a large scale of the adoption of electricity for main line freight service are the electrification of several hundred miles of the Chicago, Milwaukee & St. Paul's Pacific Coast extension now in progress, which has already been described in these columns, and the electrification of a division of the Norfolk & Western Ry. in the mountains of Virginia, which has recently been put in operation.

At one of the largest meetings ever held by the Western Society of Engineers, on Tuesday evening, Mar. 16, the Norfolk & Western work was described by George Gibbs, who has had the chief responsibility for its design and construction. Mr. Gibbs also described the electrification, for suburban traffic only, of the Pennsylvania Railroad's main line from Broad St. Station, Philadelphia, west to Paoli, while experience with electric operation on the New York Central R.R. was described by E. B. Katte, and on the New York, New Haven & Hartford R.R. by W. S. Murray.

Chief interest centered, however, in Mr. Gibbs' description of the very remarkable work which has been done on the Norfolk & Western R.R. The advocates of electrification have frequently urged the possibilities in the adoption of electric motive power in place of steam through the production of locomotives of greater tractive power than any steam locomotive. The development of the Mallet compound locomotive, however, has so generally satisfied the needs of the railways for locomotives of great hauling power that it has been difficult to prove any economic saving by the large capacity electric locomotives. The Norfolk & Western installation is the first in the world where the high-power electric locomotive has superseded the Mallet compound.

The division of the Norfolk & Western which has now been electrified extends from the Pocahontas coal fields eastward about 35 miles and the traffic over it is chiefly coal, east bound. It is handled under closely competitive conditions, so that a very large volume has to be handled to make the traffic profitable; and the present traffic is

40,000 to 60,000 tons a day. The coal is hauled in trains weighing 3250 tons made up chiefly of steel hopper-cars of 100 tons capacity, equipped with six-wheel trucks. There are long and heavy grades of 1 to 1½% against the traffic, and at one point a long 2% down grade. These 3250-ton trains have hitherto been handled over this division by three Mallet compound locomotives at an average speed of only seven miles per hour.

To further complicate the operating conditions, there is a long tunnel on the upgrade, and operation of trains through it with the enormous volume of smoke and steam discharged by these heavy Mallet compounds is made possible by the tunnel ventilating system invented by Chas. S. Churchill, Assistant to the President of the Norfolk & Western. Air is forced in at the lower end of the tunnel by a large fan through an injector portal and is carried along in the same direction as the train. The air current is given a velocity of about seven miles an hour, while the train climbs the grade through the tunnel at about six miles per hour. This blows the smoke and steam ahead of the locomotive as it is discharged and saves the engine crews from suffocation and the smoke does not overtake the locomotive ahead until it emerges from the tunnel. It will be evident that this tunnel furnished an additional reason for the adoption of electric traction.

The new Norfolk & Western electric locomotives represent a very important advance in railway engineering not only because of their enormous tractive power, but because through the development of a new type of apparatus by the Westinghouse Electric Co. the single-phase current collected from the overhead wire is used to drive three-phase motors on the locomotive.

An objection which has hitherto prevented the use of three-phase current on American electric railway work has been the necessity of using three overhead trolley wires. The three-phase motor, however, while essentially a single-speed or two-speed motor, has the great advantage that the motors automatically act as generators in descending a grade when the speed exceeds a certain amount and the current generated is returned to the line. It is there available, of course, for supplying any other train then using current for power; or, in the event that more current is delivered back to the line than is being drawn from it, the surplus is automatically taken care of by a water rheostat at the power station.

In the month during which one section of the line has been under electrical operation it has been demonstrated that the electric locomotive can move the trains over the division at an average speed of 14 miles per hour, as compared with the 7 miles average of trains hauled by the Mallet compounds. Equally important is the reduction in delays to trains on account of troubles with motive power. These electric locomotives without doubt develop a greater power than any machine ever used on a railway. While the trains are being accelerated, the motors develop as high as 11,000 hp.; and while running at regular speed up the grade, a continuous output of 8000 hp. is maintained. This surpasses the record of even the huge triple-compound Mallet locomotive with a set of driving wheels under the tender, designed by George Henderson and built by the Baldwin Locomotive Works for the Erie R.R. a year ago.

Of equal interest with the motive power is the line equipment which has been designed by Mr. Gibbs and adopted for both the Norfolk & Western and the new work on the Pennsylvania R.R. The criticism which has often been made of the line construction adopted by the New York, New Haven & Hartford for its single-phase electrification is its high first cost and also the inevitably heavy expense of maintenance of the structural steel work, with its multitude of small lattice bars and riveted connections. Mr. Gibbs' design for the structure supporting the overhead catenary on the Norfolk & Western and Pennsylvania lines consists of a pair of substantial tubular steel poles, set on either side of the track, between which a heavy cable is stretched. From this cable the catenary wires are suspended. To withstand the pull of the cable, each of the poles is guyed by a pair of very heavy round steel rods, extending to a ground anchor and provided with turnbuckle adjustment. This is by far the most substantial and businesslike overhead construction for single-phase electric traction yet developed.

It will be evident that under present conditions of railway finances, railways are not likely to undertake electrification work unless a very convincing demonstration can be made of decreased operating expenses enough to pay a large return on the necessary investment. That the Norfolk & Western and the St. Paul are both undertaking large electrical installations under these conditions is indeed significant.

Letters to the Editor

Safety Factors in Dam Design

Sir—For use in a book on the design of dams, I am trying to reach as many engineers as possible for an expression of opinion as to the proper safety factors to allow in the design of masonry dams for overturning and for sliding as based on frictional resistance alone.

I realize, of course, that such a statement might be much qualified, but there certainly could be such a minimum value under perfect conditions for remote or unimportant structures and a conservative value for important structures or those the failure of which would be a catastrophe.

Will you publish this letter in the hope that replies may be elicited from others than those directly reached by the writer?

C. A. Mees.
Designing Engineer, Southern Power Co.
Charlotte, N. C., Mar. 8, 1915.

What Is Wrong with the Engineering Profession

Sir—In your issue of Mar. 11 appears a communication under the heading, "What is Wrong with the Engineering Profession," and a reply by the Editor, in the course of which appears the statement:

Admittedly, as our correspondent says, most engineers are chiefly engaged in the routine work of measuring and computing, and a few only are required to do the work of original planning and the executive work of directing.

In the same issue I read of the appointment of an engineer as Town Manager of Norwood, Mass., who will be in charge of the departments of police, fire, streets, engineering, municipal water plant, electric-light plant, building inspection, repair of school and library buildings, purchase of supplies of all departments, appointing, discharging and fixing salaries and wages of all employees.

Admittedly he must be a man of broad knowledge and experience to successfully fill this position where a single mistake of judgment might cost the town thousands of dollars.

Salary, $3000 per year.

Is this man to be classed as an "artisan" or a member of "the greatest of all professions?" Does not the question, "What is Wrong with the Engineering Profession," stand out strongly in the compensation returned for the duties of this position?

NOT ONE OF THE 420 APPLICANTS.

[A salary of $3000 a year in a New England town of 10,000 inhabitants will leave no question in the minds of the citizens as to whether the recipient is a member of a trade or of a profession.—EDITOR.]

State Engineering Advice in Iowa

Sir: In your issue of Mar. 4 on the editorial page you discuss state competition with private engineers. In speaking of the situation in Iowa you use the words: "Surely if such an organization is backed by the prestige of the State's university the private engineer," etc.

While your statement is general it would seem to imply that the State University of Iowa is proposing to give free service. And lest this indication should be read into your statement by those who read the editorial, permit me to say that the State University is not offering free technical service. The Extension Division of the University offers information to municipalities through its Bureau of Municipal Information, but the Engineering Department has steadfastly declined to furnish anything that could be called professional advice or professional service without charge.

WILLIAM G. RAYMOND.

Dean, College of Applied Science,
The State University of Iowa,
Iowa City, Iowa, Mar. 9, 1915.

[The confusion, if any, is due to the fact that in Iowa there are two institutions of higher learning under state control—the Iowa State College of Agriculture and Mechanic Arts, located at Ames, and the State University of Iowa, at Iowa City. The Technical Service Bureau alluded to in the editorial is an adjunct of the former institution and not of the State University.—EDITOR.]

Continual Subsidence of the Mississippi Delta

Sir—I was particularly interested in the article in your issue of Mar. 4, entitled "Granite Benchmarks on Piles," for the reason that I see therein a method for measuring the subsidence of the delta near New Orleans.

In a paper read before the American Association for the Advancement of Science at its Buffalo meeting on Aug. 25, 1896, I called attention to this phenomenon:

This question of subsidence, and the rate of the same, of the delta country, is one of great practical importance to the entire region from Mississippi Sound on the east to the western border of Louisiana and as far north at least as the old Gulf shore line near Donaldsonville. The average rate of subsidence on the delta proper, i.e., from the Gulf to, say, a point 25 mi. up the river, is about ⅝ in. per annum. Above this 25-mi. point no doubt the rate of subsidence gradually diminishes until at Donaldsonville we should expect to find no settlement outside the old estuary. By proportion of distances we might reasonably estimate the subsidence at New Orleans, and east and west of it, at about one-half of the delta rate, or say ⅜ in., or in a century 5 ft. at the mouth of the river on the delta proper and 2½ ft. at New Orleans. The sinking is not therefore of practical importance so far as works at the mouth of the Mississippi are concerned, nor in relation to city improvements at New Orleans, nor in connection with the bridge over the Mississippi.

The question is, however, one of great practical importance to the outlying agricultural districts, which have no compensating conditions now that the river along its entire course in Louisiana is fully and safely leveed by the United States Government and the state.

Not only is there vertical instability at the mouth of the Mississippi, but horizontal instability as well. This is illustrated by an experience of H. C. Collins, for several years U. S. Assistant Engineer at the Mouth of the Mississippi, described as follows in the paper presented in Buffalo:

The experience of Mr. Collins was upon "Stake Island," a low-lying but assumed to be stable land of old formation, near the mouth of Southwest Pass. His experience was in 1871 and subsequent years.

The baseline on this island, which the writer has endeavored to restore, was used for the triangulation of the mouth of the pass, the United States Engineers' and Coast Survey maps being based upon it, also the location of the buoys of the Lighthouse Department.

When Mr. Collins took charge he measured the baseline, which had been laid down by his predecessor, and he found it incorrect—too long for the recorded length and the angles measured from it to all prominent points of the triangulation considerably out. The line as laid down on the start and in the notebooks was exactly 700 ft.; he found it by the most accurate measurements to be 704.26 ft. He reported to his superior that the old baseline and angles were incorrect; this was in July. In November of the same year, 1871, he remeasured his own angles and found them all out. The following summer an accurate remeasurement of the baseline made it more than 707 ft. In 1875, after returning to Southwest Pass from Pass à L'Outre (which had been used for three years as the navigation pass, until 80 acres of land rose almost in a day from a depth of 8 ft. below the surface to 10 ft. above the surface), he remeasured his baseline and found it over 712 ft. Note the following quotation:

Then I made a large comparative chart, and in doing so found that in the various readings of any angle at the bar or the baseline or anywhere on the whole survey, any angle that had ever grown larger at any survey, than it was at the one before, had kept on getting larger, and any one that had once decreased kept on doing so, and so with all outer instrument points.

The delta country in the vicinity of New Orleans is probably 2000 ft. thick, down to the hard floor of the old Gulf bottom. The only permanent benchmarks are at least 100 mi. inland, but precise levels and unchangeable benchmarks exist down to that point, and from these benchmarks new precise levels could be run every few years to the granite benchmarks referred to in your recent issue.

I hope the New Orleans Sewer and Water Board, so ably served by Mr. Earle, its Superintendent, will take steps to check up the rate of subsidence of the delta country near New Orleans, as it is a matter of considerable importance to know, approximately at least, this rate.

ELMER L. CORTHELL.

North Egremont, Mass., Mar. 8, 1915.

Annual Convention of the American Railway Engineering Association

The 16th annual meeting was held at the Congress Hotel, Chicago, Mar. 16 to 18; in fact, Mar. 19 also was practically a convention day, being assigned as a special day for visiting the extensive exhibit of railway materials and appliances at the Coliseum. There were six business sessions, and on Tuesday evening many of the members attended a special meeting of the Western Society of Engineers, at which several papers on railway electrification were presented. The only entertainment was the annual dinner, at which the principal addresses were made by Charles S. Gleed, President of the Missouri & Kansas Telephone Co.; Sir George Foster, Minister of Trade and Commerce, Canada; and Frank Mulholland, President of the International Association of Rotary Clubs.

The annual address was delivered by the President, Wm. B. Storey (Vice-President, A., T. & S. F. Ry.), at the open meeting. It reviewed the unsatisfactory condition of the railway situation, due to the financial stringency, the war in Europe and the persistent tendency toward adverse legislation. This situation is reflected in the affairs of the association. One effect of the war has been the cutting off of the supply of creosote oil from Germany for wood preservation. While this might be offset by development of the industry in this country, manufacturers are not inclined to undertake this, since the low-priced foreign product will again be available when the war is ended. This condition has led to changes in the materials and methods of treatment for ties. A specially unfortunate condition is that the American Railway Association has withdrawn its financial support of the extensive research work that has been carried on by the rail committee of the Engineering Association for some years, and which has proved of very considerable scientific and commercial value, with direct benefit to the railways.

The officers for 1915 are as follows: President, Robert Trimble, Chief Engineer of Maintenance of Way, Pennsylvania Lines (Northwest System), Pittsburgh, Penn.; Vice-Presidents, A. S. Baldwin, Chief Engineer, Illinois Central R.R., and John G. Sullivan, Chief Engineer, Canadian Pacific Ry. (Western Lines); Treasurer, Geo. H. Bremner; Secretary, E. H. Fritch, 900 S. Michigan Ave., Chicago.

The 22 committees all had reports, and all of these were printed in advance of the meeting. A general review of the proceedings is given below, with some notes as to the main features of the reports.

Roadway and Track

Roadway—This committee submitted specifications for the trimming, sodding and seeding of slopes to prevent slips and slides. It discussed also the prevention and cure of water pockets in roadbed, and mentioned a case where a steam roller was used to consolidate a fill and give an impervious top to shed water. In this connection it showed the value of a heavy bed of ballast to distribute the load and prevent ties from indenting the roadbed. The report included some notes of deflection tests on roadbed and on ballasted-floor trestles. There was some little discussion on the revised specifications for grading, mainly in regard to the measurement of excavated material in excess of the authorized cross-section and the material in slips extending beyond the slope lines.

Ballast—The committee repealed former recommendations that special tests should be made in track under actual traffic conditions to determine the proper depth of ballast of different materials which would insure uniform distribution of load upon the roadbed. As it appears impracticable to provide a fund for such investigations, it was suggested that individual railways might undertake the tests suggested.

The committee submitted also some changes in ballast cross-sections, and these were discussed at some length. The discussion showed that such sections are largely theoretical, due to the forcing of the ballast into the surface of the roadbed. There is also great diversity of opinion as to forms of ballast cross-section.

Ties—This committee submitted formulas for determining the economy of any tie whose price and life are known, and discussed the distribution and care of wood ties (treated and untreated) and steel ties. It gave also its annual progress report on the use of various steel and concrete ties on different railways.

Wood Preservative—The committee submitted a specification for a creosote-and-tar solution, in view of the fact that such solutions are being used for the purpose of economy, although the advisability of their use is still in question. It also presented rules regarding the allowance for water in creosote oil. The specifications and rules were adopted.

Rail—Since the adoption of two types of rail section by the American Railway Association this committee has been studying the performance of the rails, and now submits a single set of sections for 100 to 140 lb. per yd. The 130- and 140-lb. sections are not considered necessary but are given to show the ideas of the committee in regard to such development. In regard to long rails, it is considered that a 45-ft. length would give a better riding track and be economical, providing it involved no additional cost. Trial use of lengths from 33 to 45 ft. is recommended.

The report was accompanied by several appendices relating to special investigations. The committee's specifications for joint material cover high-carbon bars of 85,000 lb. tensile stress; medium-carbon bolts, 55,000 lb.; heat-treated bars and bolts, 100,000 lb. These were adopted. Dr. P. H. Dudley, of the committee, outlined the results of some investigations as to fissures in rail heads.

Track—The committee submitted tentative plans and specifications for manganese-steel frogs and crossings. It also submitted typical layouts for turnouts and crossovers, but these were criticized as not providing for proper interlocking connections and were referred back to the committee. For crossovers between tracks 13 ft. c. to c. the crotch frog is placed 6 ft. and 7 ft. from track centers, in order to guard the frog and crossing points more effectively than where the arrangement is symmetrical. The committee recommended further study of the economics of track labor, with particular reference to permanent forces for track work.

Signs, Fences and Crossings—As to the relative economy of signs, the report estimates that metal signs properly protected by paint and concrete will last as long as concrete, and two to three times as long as wood. The average life of wood signs is 8 to 10 years. As to fence posts, it is thought that well made concrete posts should

last 30 to 40 years, if not subjected to shocks and severe strains. Where cedar and locust posts can be bought for 16 to 18c., with a probable life of 15 years, there would be little economy in using concrete posts at 25c. unless they last over 30 years. But neither metal nor concrete posts have passed the experimental stage as far as life is concerned. The report included a specification for the construction of track crossings in paved streets, using 9-in., 141-lb. girder rails and stone-block paving, but this was referred back to the committee for further consideration.

Yards, Signals and Electrification

Yards and Terminals—A special feature of this committee's report was a description of the use of charts for analyzing the working capacity and train movements of the new union station at Kansas City. This was done by both the Belgian and the Coördinate systems, for the purpose of comparing the merits of the two systems. The report discussed developments in the handling of freight by mechanical means (especially the use of motor trucks). It also presented detailed figures of the cost of switching in gravity and flat freight yards.

Signals and Interlocking—The committee submitted a list of requirements for switch indicators (including the information to be given to train crews as to the condition of the block section). It suggested also that a list of the conclusions, standards and specifications of the Railway Signal Association should be given in the "Manual" of the American Railway Engineering Association, as matter of information. The report included the findings of the American Railway Association's committee on automatic train-control systems; also table of the rating of operative units in joint mechanical interlocking plants, for the purpose of division of costs between the several roads concerned. For future work the committee suggested the problem of signaling single-track roads with reference to the effect of signaling and proper location of sidings on the capacity of the line.

The only discussion was over the question of including the above list in the "Manual," thus appearing to endorse matters that have not been acted upon by the Engineering Association. As many of the committee members are members also of the Signal association, and the standards, etc., are in general use by leading railways it was voted that the list be printed.

Water Service—The report gave tabulated statistics of deep wells and deep-well pumping on a number of railways, and discussed the use of boiler compounds on locomotives to prevent both foaming and scaling. There was also a summarized review of pumping machinery.

Electricity—This committee submitted a revised clearance diagram for roads having electric operation, and also specifications for crossings of electric wires and cables over railways.

Economics of Railway Location—This lengthy report presented a number of conclusions, and three subcommittee reports dealt with grade and curvature, the economic aspects of railway location, and the relation of mechanical stokers and superheaters to fuel consumption. A minority report dissented from some features of the main report. The report was under fire throughout a long discussion, this being due to the importance of the subject and the varying opinions on several points. The discussion served to show pretty strongly the close relation of engineering to the operating and financial sides of railway management.

Bridges and Buildings

Iron and Steel Structures—The main part of the report related to painting as a means of protection against corrosion, and an extended tabulation showed the materials and methods employed at various bridge shops and by different railways, the latter covering both shop and field painting. There were also progress reports on column tests, on turntables and on the elastic-strength requirement for steel. As to this last, the committee stated that the specifications for steel railway bridges should include some such requirement as: "The yield point is the correct indication of the elastic strength, and the specifications should require a yield point not less than 30,000 and 25,000 lb. for structural and rivet steel, respectively."

A bridge clearance diagram with enlarged dimensions was submitted, and led to a sharp discussion. On the one hand it was urged that greater clearance is necessary, while on the other hand it was urged that any additional clearance would soon be taken up by increased dimensions of equipment. The new diagram was rejected by a close vote.

Wooden Bridges and Trestles—The report dealt mainly with an inquiry as to the use of lag screws for fastening guard timbers to bridge ties. It recommended: (1) That bridge ties and guard timbers should not be dapped or boxed; (2), that alternate ties should be fastened to the stringers; and (3), that the guard timbers should be fastened to each tie by a lag screw. It suggested also a comparison of the cost of ballasted-deck pile trestles and concrete trestles. The discussion showed that several railways use guard rails without dapping.

Buildings—The committee submitted requirements for rest houses for trainmen (at points having no hotel accommodation). It reported also on the heating, lighting and sanitary provisions for medium-size stations.

Masonry—General information was presented as to the practice of different railways in regard to concrete piles and surface finish for concrete structures.

Miscellaneous

The Committee on Records and Accounts submitted a subdivision of two items in the Interstate Commerce Commission's classification of operating accounts. It had been instructed to continue the study of reports required by Federal and State railway commissions, but stated that there is a tendency for State commissions to await the valuation of the Interstate Commerce Commission. This tendency is commended as leading to more satisfactory results and avoiding conflicting statements. The Committee on Rules and Organization submitted rules relating to the safety of employees in the maintenance-of-way department.

The Committee on Uniform General Contract Forms submitted a form of bond and a revised form for general contract. It stated that a number of important roads are using the forms previously recommended. The committee on Grading of Lumber submitted tentative grading rules for hemlock and yellow pine. The report of the committee on Conservation of National Resources included a review of railway experiments in tree planting and reforestation. Most of these have been on a small scale and generally unsuccessful, but there are some exceptions.

Placing a Jointed Concrete Pressure Pipe Inside a Brick Tunnel

The improvement of the Gunpowder water-supply for the City of Baltimore, Md., now under way, made necessary the lining of nearly a mile of old 12-ft. brick tunnel which was not in the best of condition to withstand the 90-ft. head put upon it by the new design. This tunnel, connecting Lakes Clifton and Montebello, is in constant use for the present water system, and, since the storage lake carries only a three days' supply, the problem of lining was complicated by the short shift of work which could be allowed between unwatering and refilling the tunnel and storage reservoir, and by the fact that all work put

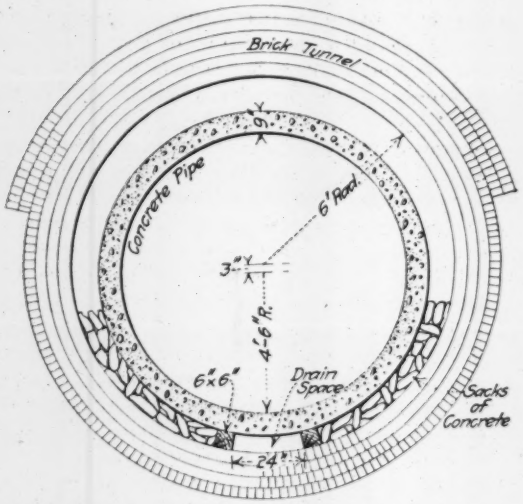


FIG. 1. SECTION THROUGH OLD BRICK TUNNEL, BALTIMORE WATER-SUPPLY, WITH NEW CONCRETE PIPE LINE

in during one shift would have to be subjected to the flow through the tunnel during the refilling period immediately after the shift.

To meet the conditions it was decided to put in the tunnel a jointed reinforced-concrete pipe to form a conduit capable of withstanding in itself the 35-lb. pressure. This conduit was made up of about 3800 ft. of 9-ft. pipe and 1200 ft. of 7-ft. pipe, resting at its bottom and side on the 12-ft. brick tunnel and constituting in itself a pipe line not dependent for its strength on the backing of the brick tunnel. The novelty in the construction is the use of jointed concrete pipes at so great a pressure, and the difficulty of the operation lay in devising a scheme for placing the pipes so that fair progress could be made in the short shift allowed. The design of the pipes and their construction and placing were executed by the Lock Joint Pipe Co. of New York, using the Meriwether patent pipe.

The section through the tunnel and pipe is shown in Fig. 1. Originally, the pipe was designed to rest on the invert of the brick tunnel, but it was found that a large amount of seepage water comes into the tunnel, and therefore the concrete pipes were laid on 6x6-in. timbers two feet apart, and were backfilled with concrete placed in bags, thus allowing an underdrain of about 6x24 in. If the wood sleepers rot out in time, the concrete pipe will have a solid bearing on the bags of concrete. Each 9-ft. section was 6 ft. long and weighed 11 tons.

The pipes were cast on the ground and lowered down shafts one by one, as required. In general, the placing was carried on simultaneously from two shafts, using triplicate equipment. As noted above, Lake Clifton only holds a three days' water supply, and it was necessary to arrange the work in such a way that access to the tunnel could be had only for short periods, which in this case were 48 hr. Each working period was to be followed by a period of equal length during which time water was run through the tunnel for the purpose of again filling Lake Clifton. However, this program could not be adhered to on account of shortage of water during the past summer in Baltimore, and the contractor was, therefore, not able to get into the tunnel as regularly as anticipated, and was restricted in his progress. The method of placing the pipes is shown in the accompanying views and sketches.

The operation of placing the pipes from one of the shafts will be described in detail. An erecting truck, shown in Fig. 3, traveled on narrow-gage tracks laid on the invert of the brick tunnel. This truck carried a four-wheel rear section with a 4-hp. gasoline hoisting and driving engine and an A-frame standard on which one end of a longitudinal I-beam rested. Forward of the four-wheel truck was a two-wheeled independent truck carrying a

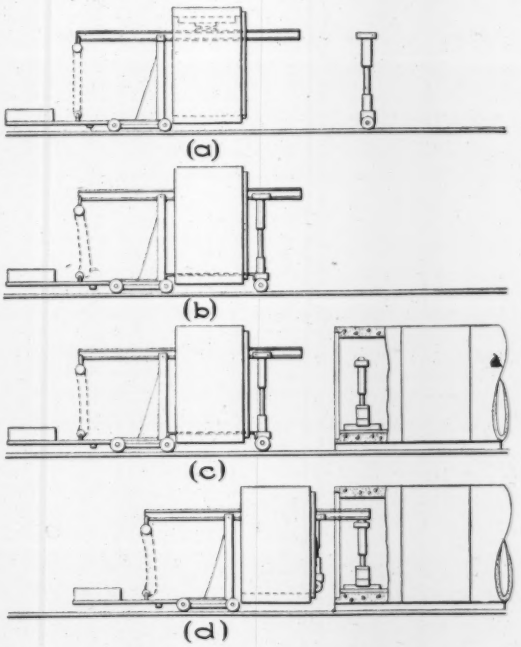


FIG. 2. PROGRESSIVE STAGES IN PLACING CONCRETE PIPE INSIDE BRICK TUNNEL

jack on which the other end of the longitudinal I-beam was mounted. This two-wheeled truck, during the erecting process, was tied to the rear wheels with detachable but rigid bars.

Fig. 2 shows diagrammatically the progress of erection. The pipe section is lowered into the shaft by a locomotive crane to a seat on the saddle on the longitudinal I-beam. This saddle is connected with the I-beam by a ball-and-socket joint so as to give free movement to the adjustment of the pipe. The forward truck at this time

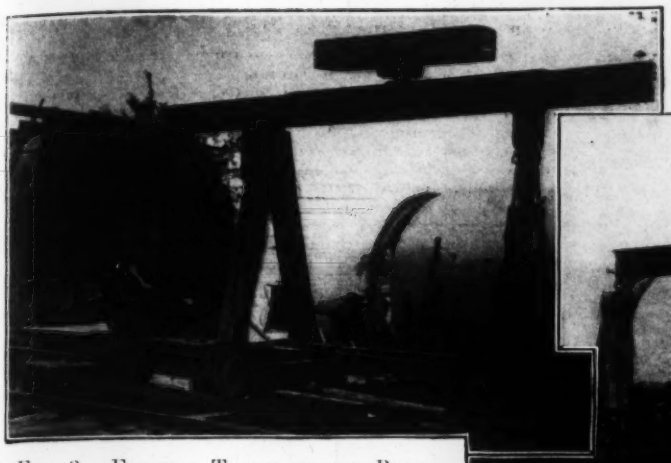


FIG. 3. ERECTOR TRUCK BEFORE BEING LOADED WITH PIPE

is free of the I-beam so as to permit the threading of the pipe onto the saddle (Fig. 2, *a*). Operation 2 is to move the forward truck back under the I-beam and raise the saddle by means of the chain block at the rear end. The forward truck is then pulled forward on a trolley on the lower flanges of the I-beam and is jacked down to the tracks. The connecting struts to the rear truck are then fastened (Fig. 2, *b*). This position of the pipe is shown in Fig. 4.

The truck is now ready to run under its own power down the tunnel to the recently erected line of pipe. At the end of the last erected pipe there is in position a screw jack mounted on blocks. This is shown in Fig. 5 and in Fig. 2, *c*. As the truck reaches the erected pipe, the overhanging end of the I-beam is allowed to come to bearing on the jack inside the erected pipe, and the forward two-wheeled truck is released and the wheels pulled up by the spring to be noted in Fig. 6. The truck is then shoved back into the new pipe and out of the way. When this has been done, the new pipe is easily slipped forward on the truck to proper bearing in the joint of the last erected pipe. The truck then returns to the shaft for another section. The sleeper blocks are placed under the new pipe and the concrete-filled bags rammed into place along the sides. This condition is

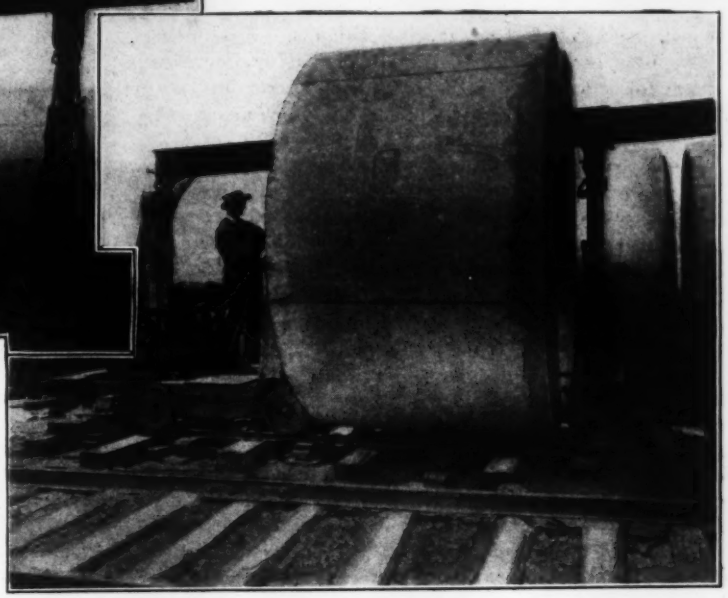
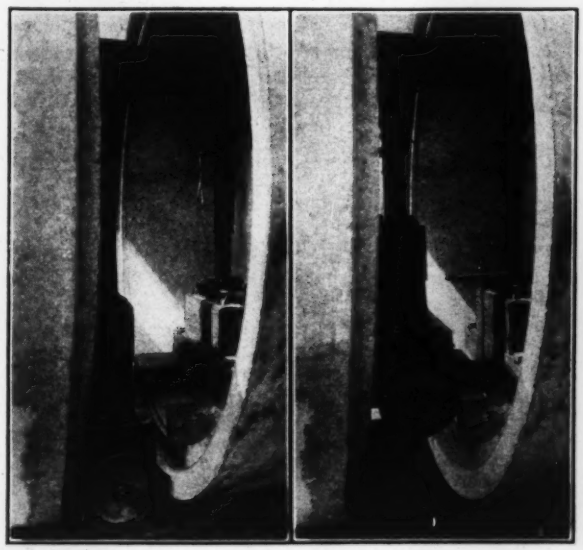


FIG. 4. ERECTOR TRUCK LOADED WITH PIPE

FIG. 7. TWO PIPE SECTIONS BEING CARRIED BY TRUCK
(Final position of pipes on truck. These pipes were set up outside the tunnel merely for purposes of taking the photograph)



FIGS. 5 AND 6. JUNCTION OF NEW PIPE AND ERECTED PIPE
(Fig. 5. New pipe carried on forward wheels of erector truck. Fig. 6. Forward wheels of erector truck lifted and pipe carried on jack in old pipe)

shown in Fig. 2, *d*, and Fig. 7 shows the truck inside of two pipes in the final erected position, the pipe there being set up in the yard merely for photographic purposes.

The narrow-gage tracks in the tunnel are set on short-length ties under each rail. The last 6 ft. in front of the erected pipe are tied together with chains, and as soon as the pipe has been erected the rail immediately before the pipe for a length of 6 ft. is sawed off with a hacksaw and the chained-together ties pulled out from under the pipe, to be set up again immediately forward.

The average haul in the tunnel from the mouth of shaft was approximately 1000 ft. The first pipe was set about 1600 ft. from one shaft and about 2500 ft. from the other, the former shaft being 1250 ft. from the end of the tunnel. The highest run for 32 continuous working hours (incidentally made with the same shift of men) was 71 pieces of pipe, totaling a length of 426 ft. The greatest number of feet placed by a single truck during this length shift was 42 pieces or a 252-ft. length. The average time to lay each pipe was approximately one hour. This included the time consumed in taking the pipes in the yard, lowering them down the shaft, loading on the tunnel truck, transporting and setting the pipes in place, together with the return trip of the truck. The truck traveled at a speed of 150 ft. per min. loaded and about 250 ft. per min. empty. The average man-hours consumed in laying the pipe was 12 man-hours per piece of pipe or 2 man-hours per ft. The average cost was $3.42 per piece of pipe or 57c. per ft., which cost does not include the placing of the mortar joints between the pipes.

As stated above, the work was done by the Lock Joint Pipe Co. for the Water Department of the City of Baltimore, under the direction of Ezra B. Whitman, then Chief Engineer of the Water Department. Emory Sudler and P. A. Beatty were engineers in charge of the work.

Engineers and the New York State Constitutional Convention

A well attended meeting of members of the national engineering societies to consider what changes engineers should try to secure in the constitution of New York State at the Constitutional Convention, which will open in Albany in April, was held on Mar. 17 at the House of the American Society of Civil Engineers in New York City. The meeting was in charge of Arthur S. Tuttle, Deputy Chief Engineer of the Board of Estimate and Apportionment of New York City, who, with Henry W. Hodge, Consulting Engineer, New York, and Alfred D. Flinn, Deputy Chief Engineer of the Board of Water Supply of New York City, will represent the American Society of Civil Engineers at the Constitutional Convention.

To help crystallize and unify opinion, the three engineers submitted to the meeting ten suggestions. Discussion of these suggestions was requested, and also votes on each to get "the sense of the meeting." A lengthy and spirited discussion ensued, with the net result that all the suggestions were adopted, except in so far as they proposed to require the Governor of New York to fill certain offices from lists of engineers selected by the governing body of the American Society of Civil Engineers.

The ten suggestions were prefaced by a statement of five basic principles which the three engineers believed the new constitution should insure. These principles, which were not acted upon, but were tacitly accepted, were as follows:

(a) A short ballot, thereby permitting close scrutiny of the qualifications of each candidate.

(b) The selection of a professional head of a department by appointment instead of election by popular vote.

(c) An uninterrupted term of office for capable bureau heads, in order that an efficient government may be maintained.

(d) The application of the civil service principle of selection for fitness to positions of major responsibility.

(e) Giving the chief executive freedom in selecting his cabinet advisers, placing upon him full responsibility for such selections.

DISCUSSION OF THE TEN SUGGESTIONS—The first three suggestions were that (1) the office of State Engineer and Surveyor (now filled by popular vote) be abolished; (2) that there be a Consulting Engineer to the Governor, appointed by the latter; (3) that there be a Department of Public Works, headed by a single Commissioner, appointed by the Governor, and that this Department should be divided into Bureaus, each Bureau having to do with engineering to be headed by a Chief Engineer.

The chief objection from the floor to abolishing the office of State Engineer and Surveyor was that this would rob the engineering profession of one elective office. This argument was advanced by W. B. Landreth, Deputy State Engineer, H. B. Seaman, Consulting Engineer, and E. L. Corthell, Consulting Engineer, New York City.

All three suggestions were vigorously upheld by Mr. Flinn, Nelson P. Lewis, Chief Engineer of the New York City Board of Estimate and Apportionment, Eugene W. Stern, Chief Engineer of the New York City (Manhattan) Bureau of Highways, and A. B. Fry, Chief Engineer of the U. S. Treasury Service. Mr. Lewis held that the selection of men for technical and professional work by popular vote was wrong in principle; that the present drift was toward appointive officers and the concentration of authority. He thought the engineering profession would obtain more recognition by having the Governor make his appointments from the leading men in the profession than to have the office open to anyone in popular favor styling himself an engineer.

It was urged that there was nothing to compel the Governor to appoint an engineer to the office of Commissioner of Public Works, but the general sentiment seemed to be that, however desirable it was to have the office filled by an engineer, it would be asking too much or expecting too much to so limit the Governor's choice. Ralph D. Mershon, Past-President of the American Institute of Electrical Engineers, remarked that it should be considered that they were there to work for the benefit of the whole community, and the engineer should be subordinated, if necessary, to that end.

Mr. Lewis spoke effectively in favor of this liberal view. He said that while the ideal commissioner would be a man with engineering training, he should be appointed primarily for his executive ability. He thought that under the present tendencies an engineer would be appointed. He felt that efforts should be directed toward insuring the establishment of engineering bureaus rather than in attempting to compel the selection of an engineer for the head of the department.

The question was then raised if it would not be better to have a commission of three or five members with six-year terms rather than a single commissioner. B. H. Waite, Division Engineer, New York State Highway Department, favored a commission because he said subor-

dinates would then hold over instead of being subject to summary removal when the head of the department changed.

Mr. Fry also spoke in favor of a commission because he believed that the state was a great loser by lack of continuity of policy in its public works; that a commission of three or five members, removable only for cause, would give this continuity of policy. Mr. Stern pointed to the single-headed federal government departments as having continuity of policy in spite of changing heads.

The fourth suggestion, to establish a Department of Public Utilities headed by three commissioners, appointed by the Governor, in place of the two present Public Service Commissions of five members each, met with general approval except regarding the participation of this department in construction work. Several speakers expressed the opinion that the work of the department should be regulatory only. It was explained that no change in the present organization for building the New York City subways was contemplated in this suggestion.

The fifth suggestion, to provide that every commissioner or department charged with responsibility for regulating and supervising buildings, equipment, trade, industries or labor should include in its membership an engineer, met with hearty approval. The eighth suggestion,* to prohibit legislation which would prevent establishing a court of technical matters, the employment of referee experts, and the appointment by a court of independent expert witnesses, was approved without discussion.

The ninth suggestion, to extend the right of eminent domain so private parties can take private property for certain public uses, was declared by some of the speakers to be within the scope of the present constitution, but nevertheless it was approved by the meeting.

The tenth and final suggestion, that appointments by the Governor shall not be subject to confirmation by the legislature, was approved after slight comment.

Appointment of State Officers—As to the advisability of the American Society of Civil Engineers furnishing lists of engineers to the Governor, and the proposal to compel the Governor to select a man from such a list, there was considerable difference of opinion. Mr. Flinn suggested the following topics for discussion: (1) Should any society assume such responsibility? (2) Did the members present believe the Society as a whole would accept the responsibility? (3) Should professional societies have such functions? (4) Was the application practicable? (5) What was suggested?

The consensus of opinion was against the American Society, or any engineering society, entering upon such an undertaking. It was urged that national engineering societies should not attempt, as such, to exert influence in state affairs. Still more emphasis was put upon the undesirability of attempting to arrogate to the profession of engineering powers which no other professional or civic body now possesses. In contrast, the proposal that the engineering societies volunteer their services in helping the Governor make his selections met with applause.

In place of the proposition that state engineering offices be filled from lists submitted by officers of the American Society of Engineers the meeting adopted a resolution offered by Mr. Lewis to the effect that certain offices should be filled by engineers chosen by the Governor solely for their fitness to perform the duties of the office, and that such appointees—heads of departments—be removable from office only after charges of misconduct had been preferred, a hearing given and the charges sustained.

*Suggestions 6 and 7 related to the submission of lists of candidates by the governing body of the American Society of Civil Engineers, and were not adopted.

News of the Engineering World

A Large Drainage Contract

On Mar. 8 a contract was let for one of the largest projects connected with the proposed drainage of the Florida Everglades. The contract covers the construction of the St. Lucie Canal, from the east short of Lake Okeechobee to the south fork of the St. Lucie River, and the rectification of a portion of the river. A lock and dam will be provided to control water heights for navigation. The canal will be 24 miles long, have a bottom width of 120 to 160 ft. and a depth varying from 14 to 28 ft.; the river already has an 11-ft. depth. Total excavation will reach 20,000,000 cu.yd., all in earth.

The contract was let to the Furst-Clark Construction Co., of Baltimore, Md., by the Board of Commissioners of the Everglades Drainage District of Florida.

Report on Detroit's Transportation Problem

Barclay Parsons & Klapp, New York, retained as consulting engineers by the Board of Street Railway Commissioners of Detroit to study street-railway traffic conditions and the possible necessity for a subway, have just made an elaborate report. The larger part deals with the street-railway traffic congestion caused by the convergence of car lines to a central interchange district. To relieve the congestion the engineers recommend rerouting of the main radial lines in such a way as to loop through the interchange district without mutual interference, two-car rush-hour trains and station stops on the heaviest line, and many minor changes. For the future it is to be anticipated that the city's growth "will in time make demands beyond the possible limits of surface street-car transportation." As first relief a short street-car-loop subway is recommended. For a still later period, a long subway with independent train service is required.

Building Code Revision by Sections

A new plan has been adopted definitely for the revision of the building code of New York City. Unsuccessful efforts for some seven years to draw up and adopt a new building code—the old one being out of date—led a year

ago to the appointment of R. P. Miller as expert for the aldermanic committee. The progress of the work since then has now resulted in abandoning the attempt to adopt a code entire in favor of revision and adoption by sections. This is the same procedure as is being followed in Cleveland, but was originated independently in the New York case.

The first part to be separated out of the integral code was the fire-limits section (divided into fire limits and suburban limits). Later the plumbing section (general provisions only; detail rules to be fixed by building-bureau head) was taken up separately. These revised sections were passed some time ago. Ten other sections have now been revised, and several have been introduced in the Board of Aldermen as separate ordinances. The subdivision of the subject follows that adopted by the committee on codification of city ordinances. The following revisions have been made in preliminary form: Materials, Working Stresses and Loads, Classification of Buildings, Wood Construction, Iron and Steel Construction, Reinforced Concrete, Light and Ventilation, Exit Facilities, Elevators, and Height, Size and Arrangement of Buildings. The last-named subject has been taken out of the hands of the aldermanic committee, however, and turned over to the Board of Estimate on account of violent opposition on the part of real-estate men to any height restriction. Opposition has also been made to the elevator section, because it calls for interlocks on the shaft doors.

Bill for State Building Law in Massachusetts

The legislature of Massachusetts now has before it a report of a commission authorized by the legislature of 1913 to investigate the laws and regulations in force throughout the state relative to the construction, alteration and maintenance of buildings. The report, House Bill 1750, has just been issued and includes a bill for a state building law.

Boston is at present controlled by a building law passed and amended by the legislature, but the other cities and many of the towns have local ordinances more or less adequate. There are various inspecting authorities, so that there is inevitable confusion and duplication of effort. The scheme of the proposed law is to provide one law covering fundamentals, applicable throughout the whole state including Boston, to make certain provisions mandatory, such for instance as those having to do with floor loads and stresses, but to leave to the local authorities the power to increase the stringency of other provisions, as housing. Local building departments are undisturbed, but to insure uniform enforcement the local departments are correlated and aided by a state building department, available for advice and to enforce the law where no local departments exist. The state building commissioner is given power to issue regulations covering new or equivalent materials and fire hazard, thus providing opportunity for the inevitable change and development in materials or methods. The number of permits now required is reduced by coördination of authorities. Four standard types of building districts are established by describing the types of construction which will be allowed in each, but the localities are left free to decide which district or districts they are to accept. Local boards of appeal, on which the state building department is represented, are given power to pass upon decisions and to vary provisions of the law.

The law is carefully and conveniently arranged, a welcome contrast to the ordinary building law, especially after much amendment. Many very common but out-of-date provisions are missing, tables are freely used to save space and to facilitate reference, and standard specifications of national societies as they may be revised are made part of the law by reference.

The bill has been referred to the committees on mercantile and metropolitan affairs and hearings will soon be held.

Frederick W. Taylor

Frederick Winslow Taylor, the dean of the modern scientific management movement, died at his home in Philadelphia, Mar. 21, from pneumonia. Although best known for his work and writings in promoting scientific management, he was a mechanical engineer of wide reputation through his numerous inventions and discoveries,

Frederick W. Taylor

the foremost of which was the Taylor-White process of treating high-speed tool steel.

He was born in Germantown, Penn., in 1856, and received his early education at Phillips-Exeter Academy and Harvard University, but owing to the impairment of his eyesight he was obliged to abandon his college course and discontinue his studies shortly after entering Harvard.

Mr. Taylor then apprenticed himself to a small pump

works in Philadelphia, where he rapidly gained proficiency in pattern making and as a machinist. During the dull period of 1878 he entered the machine shop of the Midvale Steel Co., in Philadelphia, with which company he remained until 1890.

It was here that Mr. Taylor laid the foundations of his thorough knowledge of shop organization, and it was while working as shop clerk in charge of the tool room that he first began to put into effect his time-saving and efficiency-increasing ideas. In six years he was successively laborer, clerk, gang boss, assistant foreman and foreman of the machine shop, master mechanic in charge of repairs and maintenance, chief draftsman and chief engineer.

During this period he studied at night the engineering course prescribed by the curriculum of Stevens Institute of Technology, and by diligent application and hard work completed the four-year course in three years, passing his examinations and graduating with the degree of M. E., in 1883.

After leaving the Midvale Steel Co. in 1890 he fulfilled a three-year contract with the Manufacturing Investment Co., which operated large pulp mills in Maine, as General Manager. From this time dates his well-known career as a consulting engineer and efficiency expert, for in the prosecution of this work he developed many improvements in machinery and labor-saving appliances, a large number of which he patented.

Mr. Taylor was the author of numerous papers and articles and of several books, the best known of which are his "The Principles of Scientific Management," "Shop Management," and "Concrete, Plain and Reinforced," written conjointly with Sanford E. Thompson. [For a more complete biography the reader is referred to ENGINEERING NEWS, Jan. 18, 1906, p. 50, at the time of Mr. Taylor's election as President of the American Society of Mechanical Engineers.—EDITOR.]

The Suit of the Ramapo Water Co., ostensibly to prevent New York City from using the new Catskill Aqueduct, has been decided against the company by the United States Supreme Court.

Garbage Grease at Cleveland, Ohio, will bring the city $4.26 per 100 lb. for the next six months, if the highest bid received on Mar. 20 is accepted. The price for the six months now ending was $4.37. Fred W. Cummings is Superintendent of Garbage Reduction.

The Ohio Conservancy Law will probably not be "crippled" by the proposed legislation prohibiting the construction of "dry reservoirs" by conservancy or flood-prevention districts. The bill amending the law has been postponed in the Senate by a unanimous vote. This amendatory legislation would have killed the project of the Miami Conservancy District, embracing Dayton and other cities and towns.

The Southern New Jersey Water-Supply Project of the State Water Supply Commission, under which $1,000,000 of bonds were to be issued to buy the Wharton tract of land in Atlantic and Burlington Counties, for the benefit of various municipalities, has been killed by the New Jersey Court of Errors and Appeals. The court holds that the bond issue would violate the constitutional prohibition of state bond issues in excess of $1,000,000 without authorization by popular vote.

The Removal of Composite (Wood-Steel) Cars from the Interborough Subway system in New York City will begin May 1 and be completed by Dec. 1, 1915. The company has accepted an order of the Public Service Commission to this end. There are now 478 such cars in use. These are a part of the original equipment of the subway; they have steel under-frames and wooden sides sheathed with copper. At the time of their manufacture (11 years ago) they were considered the last word in fireproof car construction.

The Manufacture of Benzol and Toluol from petroleum, it is announced by the U. S. Department of the Interior, will be undertaken on a commercial scale by the Aetna Explosives Co., of New York City. The company has agreed to devote at least $200,000 to equipment for trying out the process of W. F. Rittman, Chemical Engineer, U. S. Bureau of Mines (see "Engineering News," March 4, 1915, p. 461). All inventions and improvements are to be patented and dedicated to the public. Dr. Rittman will have direction of the experimental work.

Plans and Estimates for a Rapid-Transit Railway in Cincinnati, Ohio, have been made by F. B. Edwards and Ward Baldwin. A belt-line is projected 15.6 miles long around the city, giving entrance also to seven interurban lines. About 6.5 miles would be in subway, 0.6 mile in tunnel and 8.4 miles in open line. Three alternative schemes are developed for loops in the business district. The cost of construction alone would run from $7,646,000 to $9,135,000. The totals, including all equipment, real estate, etc., would be from $11,222,000 to $13,131,000, according to the provision for the business-section loop.

A Bill to License Structural Engineers was introduced in the Illinois House of Representatives on Mar. 19. The bill has been drafted by the Legislative Committee of the Western Society of Engineers. It provides for a state board of examiners of structural engineers authorized to conduct examinations and issue licenses for the practice of structural engineering; those taking the examinations pay a fee of $20, and those receiving a license an additional fee of $30. The practice of structural engineering without a license is made punishable by fine. Persons licensed to practice structural engineering are exempt from the operations of the Illinois law forbidding anyone, save a licensed architect, to engage in the design of buildings.

The Municipal Debt of the United States in 1913 was $3,560,000,000, of which 16.2% was covered by sinking-fund assets, according to figures just published by the Bureau of the Census. The net municipal debt increased by 86.4% between 1890 and 1902 and by 115.2% between 1902 and 1913. The term "municipalities" is here used to include all "minor civil divisions" except counties. The total net debt of counties and municipalities in 1913 was, in round numbers, $3,476,000,000, divided as follows: Counties, $371,500,000, or 10.7%; cities, incorporated towns and villages, etc., $2,885,000,000, or 83%; unincorporated towns, townships, precincts, and special districts created for such purposes as road and levee construction, drainage, irrigation, fire protection, etc., $100,600,000, or 2.9%; independent school districts outside of cities, towns, and villages having over 2500 inhabitants, $118,900,000, or 3.4%.

PERSONALS

Mr. Paul E. Kressly, for some years City Engineer, and for the past year City Manager, of Inglewood, Calif., resigned Mar. 6.

Mr. William Siehenmorgan, formerly Chief Engineer of the C. & C. Electric & Manufacturing Co., Garwood, N. J., has resigned.

Mr. James A. Smith has been elected President of the Cleveland Engineering Construction Co., Cuyahoga Bldg., Cleveland, Ohio.

Mr. Arthur L. Mullergren, formerly of Poteau, Okla., is now associated with the Benham Engineering Co., Consulting Engineers, Oklahoma City, Okla.

Mr. George F. Hughes, a contractor of Council Bluffs, Iowa, has been appointed Postmaster of that city, and will retire from the contracting business.

Mr. Clinton Cowan, County Engineer of Hamilton Co., Ohio, has been appointed by Governor Willis, State Highway Commissioner, to succeed Mr. James R. Marker, resigned.

Mr. J. F. Wadsworth, of Richard Irvin & Co., Architects and Engineers, Union Bank Bldg., Pittsburgh, Penn., has been made representative of the firm at its recently opened branch office in Erie, Penn.

Mr. C. A. Stephens, Assistant Engineer of the Texas City Transportation Co. and the Texas City Terminal Co., has been appointed Chief Engineer. Mr. Stephens succeeds Mr. T. H. Kilpatrick, resigned.

Mrs. F. W. Rogers, a prominent clubwoman of Brockton, Mass., has been appointed a member of the City Planning Board. Mrs. Rogers is said to be the first woman to hold that office in Massachusetts.

Mr. Thomas S. Kemble, formerly Research Engineer of

the Ferro Machine & Foundry Co., Cleveland, Ohio, has been made Engineer of the Automobile Wheel Division of the A. O. Smith Co., Milwaukee, Wis.

Mr. Alfred C. Nelson, M. Am. Soc. M. E., formerly Mechanical Engineer with Arthur G. McKee, Cleveland, Ohio, has opened an office as a consulting and contracting engineer at 418 Rockefeller Bldg., Cleveland.

Mr. O. A. Honnold, M. Am. Inst. E. E., Electrical Engineer of the Utah Light & Traction Co., Salt Lake City, Utah, has resigned his position with that company, and expects to travel in the West for several months, on a vacation.

Mr. A. E. Holcomb, for many years Chief Engineer and Manager of the Chicago works of the Clyde Iron Works, Duluth, Minn., has been made Chief Engineer and Designer of the C. W. Roof Manufacturing Co., Grand Rapids, Wis.

Mr. F. C. Herrmann, M. Am. Soc. C. E., formerly Chief Engineer of the Spring Valley Water Co., San Francisco, Calif., has been appointed Chief Engineer of the Modesto Irrigation District, and will be located at Modesto, Calif.

Mr. Frank A. Weaver, formerly District Manager of the Cleveland, Ohio, office of the Ayer & Lord Tie Co., has resigned to establish an office at 804 Swetland Bldg., Cleveland, to specialize in material for and making installations of factory floors.

Messrs. Richard B. Franken and Edwin H. Jonson, who have heretofore conducted the firm known as the Engineering Sales Co., 114 Liberty St., New York, have dissolved partnership. Mr. Jonson will continue the business under the firm name.

Mr. A. W. de Revere, Jun. Am. Soc. M. E., has been placed in charge of the Chicago, Ill., office of the Terry Steam Turbine Co., Hartford, Conn. Mr. A. L. Searles will have charge of a new office of the company in the Michigan Trust Bldg., Grand Rapids, Mich.

Mr. Samuel Gausmann, who has been Roadmaster of Surface Lines of the Brooklyn (N. Y.), Rapid Transit System since 1911, has gone into business for himself as an expert in street railway track and paving work. He will specialize in preparing estimates, arranging contracts and supervising work.

Mr. James Shakman, formerly Assistant Chief Chemist, Bureau of Streets Laboratory, Chicago, Ill., has joined the staff of Walter H. Flood, Consulting Chemical Engineer, 326 River St., Chicago, and has assumed the direction of the road materials laboratory, which has recently been considerably enlarged.

Mr. Joseph E. Root, Assoc. M. Am. Soc. C. E., who has been Office Engineer on the sewerage investigation work made by the Division of Sewerage, Cincinnati, Ohio, has been placed in charge of the designing part of the special sewerage construction work to fill the vacancy caused by the leave of absence granted Mr. F. C. Tolles, noted elsewhere.

Mr. Henry Hornberger, M. Am. Soc. C. E., who has been engaged in consulting practice for several years, has closed his offices in the Pacific Bldg., San Francisco, Calif., and accepted a position with the Pelton Water Wheel Co., New York and San Francisco, as one of the demonstrators of their exhibit at the Panama-Pacific Exposition.

Mr. J. H. Clark, Superintendent of Floating Equipment of the Baltimore & Ohio R.R., at Baltimore, Md., has been appointed also Assistant General Superintendent of the New York division, and General Superintendent of the Staten Island lines. Mr. Clark succeeds Mr. W. H. Averell, who has been promoted to be General Superintendent, with headquarters at Wheeling, W. Va.

Mr. A. G. Eneas, who formerly organized and developed the Spray Engineering Co., has severed his connection with that concern and is now in charge of the engineering department of the newly organized Spray Manufacturing Co., 201 Devonshire St., Boston, Mass. The company is specializing in various engineering applications of spray devices. There are branch offices in New York and Chicago.

Mr. Frank C. Tolles, Assoc. M. Am. Soc. C. E., who has been Designing Engineer for the Division of Sewerage, Department of Public Service, Cincinnati, Ohio, since April, 1912, has been granted a year's leave of absence, dating from Mar. 15, 1915, to accept a position with Dr. Earl B. Phelps, Assoc. Am. Soc. C. E., Consulting Engineer for the International Joint Commission making the studies for the elimination of the pollution of the Great Lakes.

Mr. Oscar T. Crosby, until recently in active electric railway management work, has been appointed to succeed Mr. A. N. Connett, Chief Engineer of J. G. White & Co., Ltd., as general director of distribution of supplies for the Commission for Relief in Belgium, which has its headquarters at 71 Broadway, New York. Mr. Crosby has been made also a member of the Executive Committee of the Commission. His headquarters will be in Brussels, Belgium.

Mr. Robert Lee Faris, an officer of the U. S. Coast and Geodetic Survey since 1893, has been promoted to be Assistant Superintendent of the Survey to succeed Mr. Frank W. Perkins, resigned. Mr. Faris was born at Caruthersville, Mo., in 1868. He graduated in civil engineering at the University of Missouri. For two years following his graduation, 1890-91, he was U. S. Assistant Engineer on the survey of the Missouri River. He then joined the U. S. Coast and Geodetic Survey, where for the last nine years he has been Inspector of Magnetic Work and Chief of the Division of Terrestrial Magnetism.

Messrs. Edward Wegmann, M. Am. Soc. C. E., and A. G. Hillberg announce that they have established offices in the South Ferry Bldg., New York City, to engage as consulting hydraulic engineers on water-works, water-power developments, sewer systems, irrigation and drainage projects. Mr. Wegmann was for more than 30 years connected with the construction of the Croton water-works for the City of New York. He was the last Chief Engineer of the Aqueduct Commissioners, and subsequently for four years was Consulting Engineer of the Department of Water Supply, Gas and Electricity. Mr. Hillberg has been connected with large hydro-electric developments, notably the Mississippi River Power Co.'s plant at Keokuk, Iowa. For the past two years he has been Associate Editor of the "Engineering Record."

Mr. Preston K. Yates, M. Am. Soc. C. E., the author of the paper on the New Haven Trap Rock Co.'s plant, published in this issue, has for a number of years made a specialty of the design of large rock-crushing plants. The great plant of the Tomkin's Cove Stone Co., on the Hudson River, built under his direction, was described in "Engineering News" of Jan. 12, 1911. Mr. Yates graduated from Rensselaer Polytechnic Institute, in the class of 1880, and was for many years associated with the late Alfred P. Boller on the construction of some of the important bridges in New York City and vicinity. From 1896 to 1900 he had charge of some of the large contracts on the Metropolitan water-supply and sewerage system in Massachusetts. He was for four years manager of a large Cleveland contracting firm engaged in building docks, breakwaters, dredging, etc., and from 1904 to 1907 was principal assistant engineer of the Lake Shore & Michigan Southern R.R. He has been for a number of years past engaged in consulting engineering work with offices at 30 Church St., New York City.

OBITUARY

Charles C. Teal, Secretary and Treasurer of the National Engineering Co., Philadelphia, Penn., died recently at his home in that city after a long illness.

Frederick Arthur Hall, a mechanical engineer for many years connected with the Yale & Towne Manufacturing Co., New York and Stamford, Conn., died Mar. 16 at his home in Passaic, N. J.

Eugene B. Cook, Superintendent at Cleveland, Ohio, of the Toledo division of the New York Central Lines, was killed by a train in that city Mar. 14. Mr. Cook had been in the company's service 33 years. He left a widow and four children.

William McIntosh, M. Am. Soc. M. E., formerly Superintendent of Motive Power of the Central R.R. of New Jersey, died at his home in Plainfield, N. J., Mar. 15. Mr. McIntosh was born at Franklin, Que., in 1849. He began railway work in 1864 as locomotive fireman on the Chicago, Milwaukee & St. Paul Ry. Mr. McIntosh was the inventor of a number of locomotive and car appliances.

Richard Hubbell, a civil engineer at one time connected with the construction of the Canadian Northern Ry., died recently at Winona, Minn. When the Duluth, Winnipeg & Pacific Ry. extended its line from Cook to Fort Francis, Mr. Hubbell was Assistant to Chief Engineer W. H. Hare, who had charge of the work, with headquarters at Virginia, Minn.

Charles Francis Adams, at one time President of the Union Pacific R.R., and for ten years a member of the Massachusetts Board of Railroad Commissioners, died at his home in Washington, D. C., Mar. 19, from pneumonia. He was a grandson of John Quincy Adams. He served in the Union Army through the Civil War. Mr. Adams was one of the foremost historical writers in the United States. He was interested chiefly in the history and the political and economical problems of this country. Among his works are several on railway economics,

including, "Railroads, Their Origin and Problems" and "Notes on Railway Accidents." Mr. Adams was born at Boston, Mass., in 1835. He was a graduate of Harvard University.

Walter A. McFarland, M. Am. Soc. C. E., Superintendent of the Water Department of Washington, D. C., died at his home in that city Mar. 17. Mr. McFarland was born in Brooklyn, N. Y., in 1864, and was a graduate of Lehigh University. From 1888 until 1896 Mr. McFarland was engaged in engineering work under the Corps of Engineers, U. S. A., the first two years as Assistant Engineer on river and harbor work in New York and Connecticut, and after 1890 as Resident Engineer on the U. S. Muscle Shoals Canal, Tennessee River, Ala. In 1896 Mr. McFarland was appointed Superintendent of the Water Department of the District of Columbia, and he held this position until the time of his death. Soon after this appointment he was commissioned to reorganize the Department and rearrange the system of distribution. The system, developed and constructed in accordance with his plans, includes the Brightwood Reservoir, the District Pumping Station, which is one of the most interesting of its kind in the country, and the main trunk lines for the water-supply of the District.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN CHEMICAL SOCIETY.
Mar. 31-Apr. 3. Meeting in New Orleans. Secy., Charles L. Parsons, Box 505, Washington, D. C.

AIR BRAKE ASSOCIATION.
May 4-7. Convention at Chicago. Secy., F. M. Nelis, 53 State St., Boston, Mass.

AMERICAN WATER WORKS ASSOCIATION.
May 10-14. Annual meeting in Cincinnati. Secy., J. M. Diven, 47 State St., Troy, N. Y.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 17-20. Annual meeting at Chicago. Secy., C. G. Hall, 922 McCormick Bldg., Chicago.

MASTER BOILER MAKERS' ASSOCIATION.
May 25-28. Convention at Chicago. Secy., Harry D. Vought, 95 Liberty St., New York City.

Society of Automobile Engineers—The summer meeting will be held in the afternoon of June 14 on board a vessel leaving Detroit for Georgian Bay, returning to Detroit on the afternoon of Thursday, June 17.

Illuminating Engineering Society—A special mid-season meeting of the New England section of the Illuminating Engineering Society will be held at the Engineers' Club, Boston, Mass., on Mar. 26. The Secretary is S. C. Rogers, 21 Red Rock St., Lynn, Mass.

American Institute of Electrical Engineers—At the regular monthly meeting of the Board of Directors, on Mar. 12, in New York City, the following nominations were announced: For President, John J. Carty, New York; Vice-President, Comfort A. Adams, Cambridge, Mass.; J. Franklin Stevens, Philadelphia, Penn., and Wm. McClellan, New York. For Managers, John B. Taylor, Schenectady, N. Y., C. E. Skinner, Pittsburgh, Penn., F. B. Jewett, New York, Harold Pender, Philadelphia. For Treasurer, Geo. A. Hamilton, Elizabeth, N. J. The election ballot will be mailed to the membership not later than Apr. 1.

Boston Society of Civil Engineers—The 67th annual meeting of the Society, held at the new City Club in Boston on Mar. 17, was in effect a continuous session from noon to midnight. Starting with a business meeting of more than routine interest, it progressed smoothly through a dinner at 1:30 o'clock, with fully 200 in attendance. A lecture on "Water Storage," by Frederick H. Newell, at 3, a visit to the Dorchester St. subway construction at 6 and a crowded and enthusiastic smoker at 7 o'clock. Retiring President Harrison P. Eddy presided at the formal meetings. For the ensuing year Charles R. Gow was elected president, his election and that of his associates in the management of the Society being announced by a realistic "extra" distributed by newsboys at the dinner.

The Boston Society of Civil Engineers is in a pleasantly prosperous condition, due partly to its established place in the engineering community and partly to an energetic and progressive conduct hardly compatible with its advanced age. During the past year it has increased its membership from 837 to 1004 and its financial condition, as represented by a growing "permanent fund," is of the best.

One of the most valuable contributions to the meeting was the presidential address of Mr. Eddy, a thoughtful and concise study of the duties and functions of a local engineering society, particularly as exemplified in the Boston Society of Civil Engineers.

Among other things it was announced that Clemens Herschel and Hiram F. Mills were elected honorary members and Joseph R. Worcester was awarded the FitzGerald medal for his paper on "Boston Foundations."

Appliances and Materials

Trench Tamper

The latest development of the Staley tamping machine for trench work (described in "Engineering News," Feb. 20, 1913) is shown in the accompanying figure. In the original design the tamping was done by a vertical-shod timber falling freely by its own weight. In the new design, the rising timber compresses a set of heavy spiral springs, which (on the release of the timber) add to the speed and force of the blow. The tamper is operated by a pair of gripping rolls having a part of their circumference cut away, so that as they revolve they repeatedly grip, raise and release the timber. The tamper is 2x6 in. in section, 18 ft. long, faced with steel and shod with a heavy casting. The new machine is self-propelling and has a friction-disk transmission. The range of travel speed is wide—from 10 to 20 ft. per min., tamping, up to 4 mi. per hr. when on the road. A radial frame pivoted to the main bed carries the tamper (with its rolls and springs) and gives it a horizontal range of 7 ft.

The machine can tamp from a height of 2 ft. above the surface to 8 ft. below, delivering 80 blows per min., of an

TRENCH TAMPING MACHINE

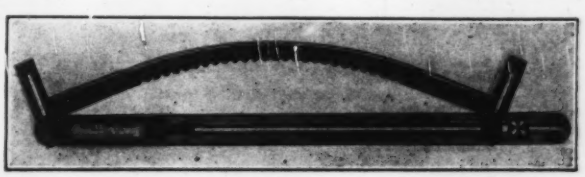
energy of about 700 ft.-lb. The tamping, swinging and propelling movements are operated from an 8-hp. opposed-cylinder gasoline engine. This new machine weighs about 5000 lb. It is built by the Lourie Mfg. Co., of Springfield, Ill.

* * *

Adjustable Railway-Curve Ruler

What is called an "adjustable arc ruler" is shown in the accompanying illustration. It is for drawing circular curves of various radii and would be a substitute for the sets of curve templates commonly used in railway drafting offices.

The ruler proper is a flexible strip in front of a series of jointed knuckle bars pivoted together; the ends are attached to straight pieces which form the tangents to the curve. One end piece is pivoted to a bar carrying the scales, and the other end is attached to a plate which slides in a slot along the bar. The instrument is shown in position for a convex



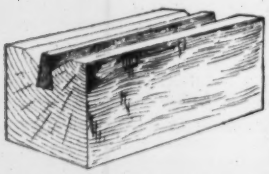
ADJUSTABLE RAILWAY-CURVE RULER

curve. For a concave curve, it is shifted to the lower side of the scale bar, by means of the slotted end pieces. The scales are graduated in inches and degrees, and the minimum radius is 3½ in. The main parts are of german silver, with celluloid for the ruling edge and scales. The instrument is made by the William S. Weston Co., 6617 Greenwood Ave., Chicago.

* * *

Wood Block for Hillside Pavements

One of the most recent of numerous attempts to free wood-block pavements from the drawback of slipperiness is shown in the accompanying sketch. This block is grooved ⅜ in. deep and an iron cleat projects ⅜ in. from the bottom of the groove, making the top of the iron flush with the surface of the block. The iron is supposed to be both hard enough and soft enough to wear uniformly with the rest of the pavement. These blocks are not used for the entire pavement, but with standard wood blocks — about every other or every third course across the pavement. These blocks are known as the "Acme" nonslip block and are made by the Philadelphia Wood Paving Block Co., Philadelphia, Penn.



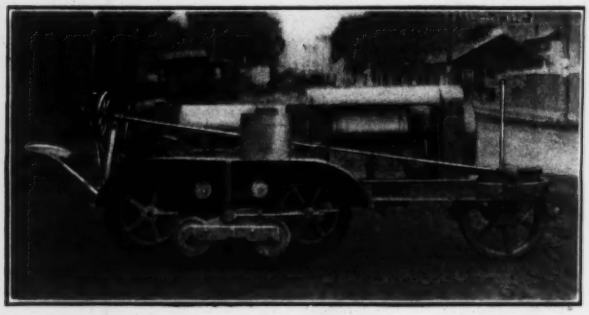
HILLSIDE WOOD BLOCK

Two pavements in which these blocks were used were laid in Boston in 1912, some 2000 sq.yd. in all, on grades of 3 and 3½%. Inquiry of L. K. Rourke, Commissioner of Public Works of Boston, discloses the fact that during the winter season, when freezing, sleety conditions prevail, these pavements seem to provide a better foothold for horses, for their calks cut through the thin ice coating, catching in the grooved portion of the block. The pavements are reported in good condition. William H. Connell, Chief of the Bureau of Highways of Philadelphia, states that in the year and four months a pavement of these blocks has been laid in that city the results have been entirely satisfactory, although there is a tendency for the iron cleat to sink further into the wood. This short stretch of pavement was laid on a 3.8% grade and is subject to much heavy traffic. So far teamsters speak highly of it and state that even in slippery weather it gives a good foothold for their horses. However, sufficient time has not elapsed to warrant a final expression of opinion.

* * *

Midget Caterpillar Tractor

After three years' development work the Holt Manufacturing Co., of Stockton, Calif., and Peoria, Ill., is producing a midget caterpillar gasoline tractor for miscellaneous contracting and farm use. It is 12 ft. long by 53 in. wide and weighs 5920 lb. The load on the ground under the caterpillar track is 4.2 lb. per sq.in. The engine is of a four-cylinder four-cycle type capable of developing continuously 18 b.hp. at 750 r.p.m. The side frame members are 6-in. 15½-lb. channels. Three speeds forward (1.4, 2.3 and 3.6 mi. per hr.) are provided and one on reverse (2.3 mi.); the drive is direct on the intermediate gear. The price is $1600.



HOLT MIDGET TRACTOR

For the present this machine is built only at the Stockton shops and is not being distributed east of the Rockies; soon plans will be completed for marketing it in the East.

* * *

Horizontal Continuous Blueprinting Machine

The accompanying illustration shows a new design of horizontal blueprinting machine to take continuous rolls or cut sheets 2 to 48 in. wide. The paper is drawn out of the storage compartment over a top roll, down the inclined feeding table with the tracing, past the feed roll, around the printing cylinder (within which is a mercury-arc lamp), over the delivery roll and into the exposed print storage box at the bottom of the machine. The printing cylinder is formed by a number of bronze-wire helical springs and secures a more perfect contact between tracing and paper, and interposes no glass between the print and the lamp. The tracings may be delivered at will to the storage chamber or to the operator for reprinting.

CONTINUOUS BLUEPRINTING MACHINE

The machine occupies a floor space 2½x5 ft.; no dark room is needed. The energy drawn by lamp and motor is 550 watts. A 1-ft.-per-min. rate of feed is recommended as allowing the operator to print, cut, wash, and dry the paper without stopping the printer. This machine is made by Wickes Bros, of Saginaw, Mich.

* * *

Titanium-Aluminum-Bronze Castings

A foundry for the manufacture of aluminum-bronze castings has been established by the Titanium Alloy Manufacturing Co. of Niagara Falls, N. Y. Such bronzes have been widely known as having many of the properties of steel and, in addition, resistance to corrosion. The metal is about 10% lighter than manganese bronze and its strength is about the same. Its wearing properties at least equal those of phosphor bronze. It can be hardened by heat treatment. Rolled aluminum bronze has been available for several years, but the difficulties with castings have been so great that their manufacture has been generally discontinued.

The company mentioned put a research chemist on the problems of aluminum-bronze casting and he found that small additions of titanium, or its compounds, had a beneficial influence. After three years' work it was considered possible to undertake to make commercial castings.

* * *

Circular "Slide Rule"

A set of circular scales printed on cardboard, with radial celluloid runner, just put out by the S. G. Carpenter Drafting & Engineering Co., 26 Baltimore St., Hartford, Conn., converts inches into decimals of a foot; gives the circumferences and areas of circles; and gives squares, cubes and roots of numbers.